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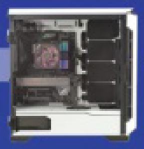

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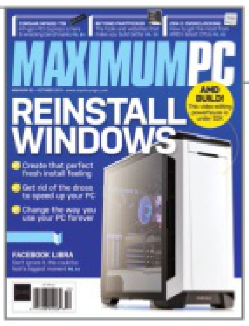

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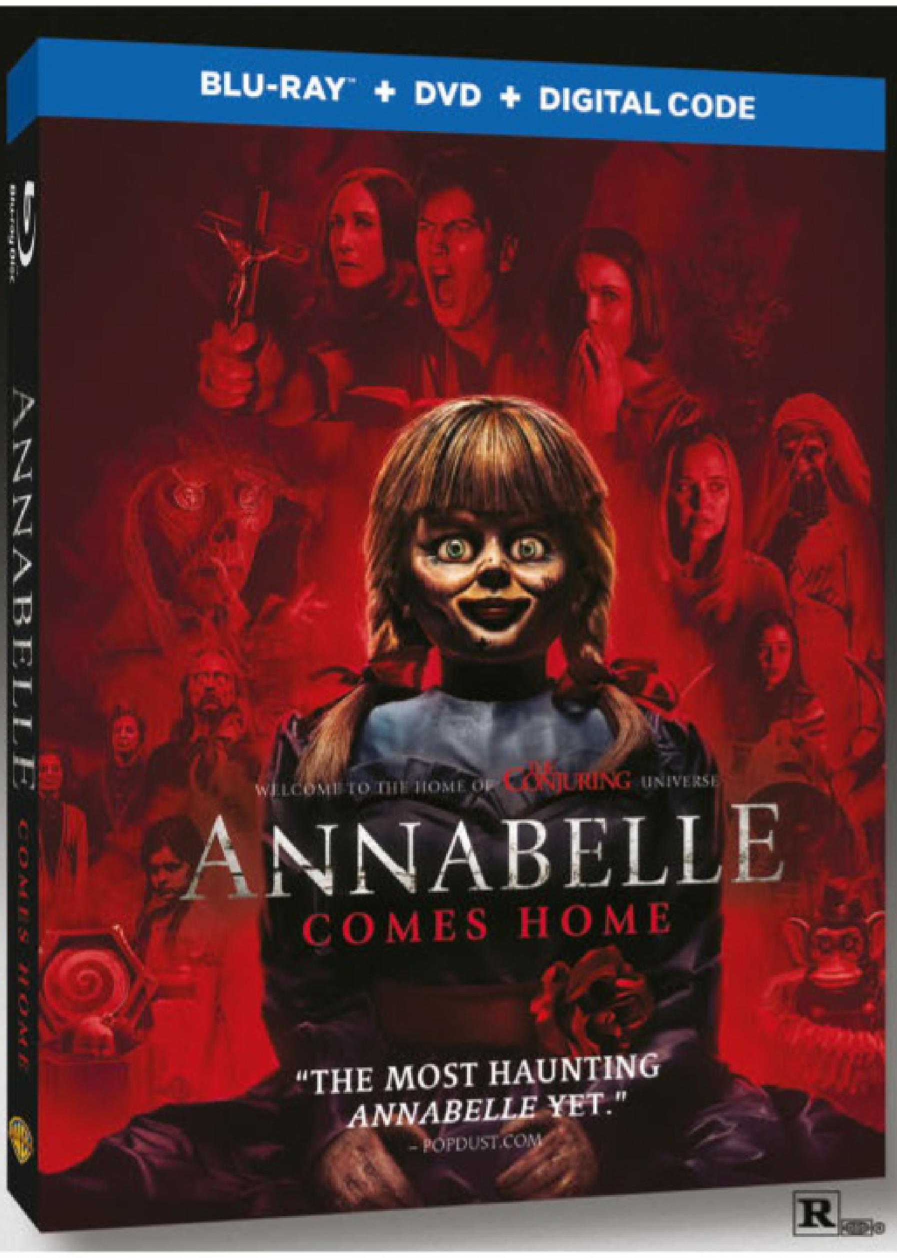
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Alan
Dexter

GET THAT NEW PC FEELING, WITHOUT LOSING A BYTE

YOUR FEELINGS on reinstalling Windows will largely be dictated by how long you've been using it, and by how the process has worked out for you before. Windows has a sordid history of filling up with dross, eventually slowing down to the point of being unusable, and hiding data and settings in the obscurest of places to make sorting it all out an unappetizing proposition. Reinstalling Windows can be frustrating, time-consuming, and flawed. It can leave you in driver hell, and may not even fix the very thing that forced you to reinstall.

Such experiences are rare now, though. Things have changed. A lot. And mostly for the better. Still, if you've been using your PC for a long time, there's a good chance that the thought of reinstalling Windows will have your anxious twitches coming back. To be fair, there are still lots of programs that misbehave enough to make such activities daunting. There's also the question of whether you should have to reinstall Windows, as surely it's getting better at sorting out its own foibles? It is, but we haven't quite reached OS nirvana yet—there are still times when reinstalling is the best option.

Starting on page 24, we walk you through reinstalling, but also consider the other options you have in these days of Windows Reset, Refresh, and Fresh Start. We also consider virtual options, setting up a slightly mad dual-boot system, and look at the best ways to back up, as you should do that before embarking on a reinstall. You may find you don't even need to reinstall.

One time you will want to reach for your trusty USB drive and the Windows Media Creation Tool is when you're building a new PC, and while we often refer to PCPartPicker, it isn't the only system-building assistant. This issue, we explore other options, and tell you why and when you should consider them for specific builds (pg. 30).

Another feature this month looks at the state of loot boxes—we consider whether they've added anything positive to gameplay, but also try to ascertain whether their days are really numbered (pg. 34). Our final feature investigates whether Libra, Facebook's already controversial cryptocurrency, stands a chance of making it out into the real world, and what sort of impact it will have if/when it does (pg. 44).

On top of that, the onslaught of new hardware releases continues, and we have reviews of Nvidia's new Super 2060 and 2080 cards, take a look at the more affordable Radeon 5700, put the first fourth-gen SSD through its paces, and look at one of the best motherboards ASRock has ever put out. We also turn our hand to Ryzen 9 3900X overclocking, show you how to get up and running with Nvidia FrameView, show you how to stream to YouTube from a RPi, and loads more. It's a packed issue—I hope you like it.

Alan Dexter is Maximum PC's *executive editor and a punisher of hardware. He's been a tech journalist for over 20 years, and has no problem upsetting the PC industry as a whole.*

↘ submit your questions to: comments@maximumpc.com

THE NEWS

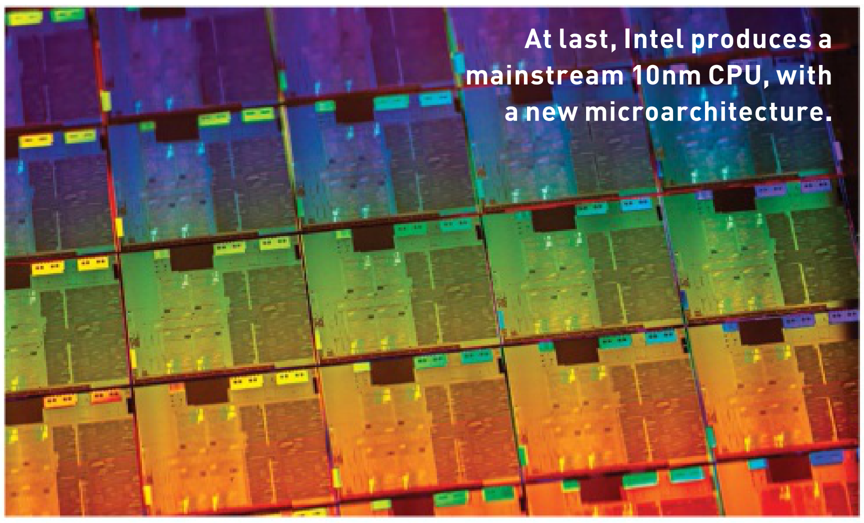
Welcome to Sunny Cove

Intel's new microarchitecture finally lands

INTEL HAS MOVED to 10th-generation chips with the imminent release of 11 Ice Lake CPUs. There are six low-power U-Series, and five even lower power Y-Series, ranging from a Core i7-1068G7 down to a Core i3-1000G1, all aimed at mobile devices. The U-Series have a 28W range-topper, but otherwise burn at a TDP of 15W, while the Y-Series make do with 9W. They carry either two or four cores, and base clocks run from just 0.7GHz to 2.3GHz, with boosts topping out at 4.1GHz. We get a new naming convention, too: The processor numbers all start with a "10" to indicate the generation, and end in a two-digit identifier to indicate the on-board graphics used. All are systems on a chip (SoC), so come with the motherboard silicon next to the CPU. According to Intel, these chips will be "redefining the next era of laptop experiences."

The big deal is that we finally have a new microarchitecture, the beating x86 core of a CPU. Ice Lake chips use Sunny Cove microarchitecture, which is destined to replace Skylake over the next few years in virtually everything. Intel has been churning out variations on the Skylake microarchitecture for years in sixth, seventh, eighth, and ninth-gen chips. Intel chip generations are more of a marketing term than anything else—when it thinks there's enough to warrant it, it blesses new chips with a bump. In this case, it is warranted. Ice Lake is also Intel's first 10nm processor, unless you count the limited number of oddball 10nm Cannon Lake chips that were quietly slipped into a few Chinese laptops. The move to 10nm was originally planned for 2016, then always appeared to be about a year away.

What's so good about Sunny Cove? Well, it promises an approximate 18 percent jump in IPC, instructions per cycle. This bodes well for the future. AMD's Zen 2 managed around 13 percent over Zen+. As we reach practical limits in clock speeds, improving performance increasingly means getting more out of each cycle instead. Sunny Cove also has useful increases in cache size. The Level 1 cache is 50 percent bigger than Skylake, now 48KB, and the Level 2 cache has been doubled, now standing at 512KB per core. Other tweaks include a greatly improved AI performance, dubbed Deep Learning Boost, although why this is going to be useful on a laptop is unclear. Early tests show that performance is going to be good, although that IPC increase is blunted a little by clock speeds—the best of the older Whiskey Lake processors still clock faster, so the overall gains are minimal. However, performance per watt, a key metric in the mobile world, is looking good.


At last, Intel produces a mainstream 10nm CPU, with a new microarchitecture.

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As well as Sunny Cove, the new Ice Lake chips have another selling point: a new graphics core—Gen11. Intel has been using Gen9 for years, under the brand UHD (the Gen10 graphics only appeared on those mysterious Cannon Lake chips). Previous on-board graphics from Intel have been adequate, but uninspiring. Gen11 moves the bar considerably. The top-tier chips carry the Iris Plus brand, appearing as G7 or G4 in the chip name, indicating either 64 or 48 execution units (Intel has a tendency to use a lot of brand names and code names, which can get confusing and/or annoying). Gen11 has support for variable rate shading and considerably faster memory. This means decent gaming at 1080p, as long as you take some care with the settings on more demanding titles. It is this more than anything that will shift these chips.

It's not the most exciting launch of a microarchitecture. In 2015, Skylake launched with much more of a bang; the Core i7-6700K jumped straight into high-end desktops. So, when will desktops get Sunny Cove? There are plenty of rumors, many of which are pessimistic—how does 2022 sound? We can certainly expect more tinkering with 14nm chips before then. Intel has the designs, what's holding it back now is the fabrication. Meanwhile, we will get a slew of new Ice Lake laptops ready for the holiday season. **–CL**

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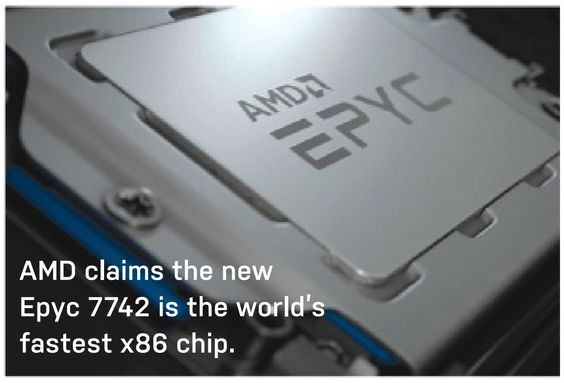


AMD claims the new Epyc 7742 is the world's fastest x86 chip.

SERVER WAR GETS HOT

AMD reaches 64 cores

AMD'S ZEN 2 architecture has reached its server chips with Rome, the second generation of Epyc processors. As well as the expected increase in instructions per cycle, and a hike in clock speeds, it is the core count that has really pushed performance—it has effectively doubled. The top model, the Epyc 7742, packs 64 cores across eight chiplets, and clocks in at 3.4GHz. At its launch, AMD made some bold statements, including claiming 80 world records running industry-standard benchmarking software, and the title of the world's most powerful x86 chip.

Pricing is competitive and impressive. The Epyc 7742 sells for just under $7,000; its rival, the 28-core Xeon Platinum 8280, is $10,000, and nowhere near as fast. The Rome chips undercut the older Naples chips, too: An Epyc 7502 bests the older 7601 in every department, but is only $2,400 versus $4,200 for the part it replaces. We knew Rome was going to be good, but it has proved far better than expected. At the launch, AMD's CEO, Lisa Su, said, "I hope it is absolutely clear that second-gen Epyc is the best in the industry."

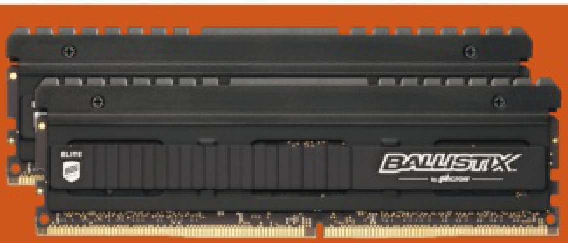
Intel also made an announcement on its server chips. It has new 56-core Cooper Lake chips coming next year, and talked of 10nm 26-core Ice Lake chips after that. Progress, but by the time Intel can respond with new silicon, AMD will be ready with Rome's planned replacement: Milan. Intel can lower prices to compete, but otherwise has little it can do other than rely on its market position. The booming server market is where you can make real money, and is vital to both companies. AMD has started to gather an impressive list of big customers, including Google and Twitter. Market watchers are predicting that it will double its market share before the end 2020. The company has been here before; the Opteron did well for a few years, but this return is very strong indeed. Epyc is giving Intel quite a headache. **–CL**

TWITTER OVERWRITES PRIVACY SETTINGS

YET ANOTHER DATA LEAK

TWITTER HAS ADMITTED that its privacy settings haven't been working properly, which has lead to people's data being shared with advertising partners, even though users had set their privacy settings to block this. The revelation came from a post in its Help Center, which said that two advertising privacy settings "may not have been working as intended." One bug would share information when you clicked an ad, whether or not you'd allowed this. A second bug would serve users with targeted ads based on their online activity. These ads are selected using "inferences," and draw on data collected outside of Twitter, including other devices. The privacy settings offer the option not to "personalize" your experience, but apparently often the user settings were simply overwritten. As Twitter's admission says, "You trust us to follow your choices, and we failed here." It transpires that Twitter had been leaking data since last spring. **–CL**

DRAM PRICES SET TO DROP FURTHER



WE'VE BEEN TOLD for a while that there is an over-production of DRAM, and prices are low. However, it appears there may well be a lot more to come. A report by Gartner (world-class research, advisory company, and developer of the Hype Cycle) claims that prices have a lot further to fall. It gives the figure of a 42.1 percent fall before the end of the year. This is a strangely specific figure, which must have been generated by some statistical method—nobody estimates in tenths of a percent. The report says there is so much excess stock in the supply chain that it will take months to clear, and prices won't stiffen until the middle of next year. Reasons include a slowing of smartphone sales, a "weaker pricing environment," and the tension between the US and China. Prices have been dropping since a high around December 2017, when 16GB of decent RAM would have cost in the region of $200; that's fallen to around $70, and is still dropping. It does sound like good news, even if it's only half right, because you can never have too much RAM. **–CL**

Tech Triumphs and Tragedies

A monthly snapshot of what's good and bad in tech

TRIUMPHS

✓ **DIABLO FOR FREE**
Two levels of the classic 1996 game are now available to play in your browser for nothing.

✓ **OLD-SCHOOL MACHINE**
Fujitsu employs an engineer to keep its 1959 FACOM128B in working order. It uses electro-mechanical relays, rather than more advanced vacuum tubes.

✓ **SMART SWITCH**
An unofficial port runs Android on a Nintendo Switch, but it occasionally bricks.

TRAGEDIES

✗ **CRYPTOTAX**
The IRS has warned owners of cryptocurrencies that it will chase any tax due.

✗ **CISCO'S LAX SECURITY**
Knowingly selling surveillance gear that was open to hacking cost Cisco a $8.6 million fine.

✗ **NO-SO-SMARTSPEAKERS**
A researcher has warned that many IoT speakers have little protection to stop malware from turning them into low-grade sonic weapons.

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Ring and Police Sign Secretive Deal

AMAZON'S RING, its Internet video doorbell, is a simple and useful idea, but keeps running into hot water. The latest chapter has a sinister air. A leaked document has shown that Ring's "Law Enforcement Neighborhood Portal" doesn't come free. In return for giving the police the ability to request footage from Ring cameras, Amazon asks them to endorse its products and assign officers to Ring-related tasks, including a social media co-ordinator and a press co-ordinator. The police department is also obliged to run "outreach" programs to promote Ring. The agreement is supposed to be confidential, but was released under a public records request.

Over 200 law enforcement agencies have joined partnership schemes, earning them free Ring units to hand out, and the ability to earn $10 toward extra units every time a user downloads the Neighbors video-sharing app. In return, the police have a live map of all the active Ring units in an area, and can request footage without going through the usual channels and obtaining a warrant. Even if the camera's owner declines the request, the police can go to Amazon for the files armed with a subpoena, although the exact legal position here isn't clear yet. The images a Ring camera captures do not belong to its owner. According to the terms of service, Amazon has unlimited and irrevocable rights to use any images captured by Ring on your doorstep. Once it has gone to the cloud, it's Amazon's.

Are you happy for the police to see who's at your door?

Ring is touted as an aid to security, and a good part of that sales pitch uses old-fashioned fear. Who doesn't want a safer community? But having every visitor to your door triggering an alert can lead to a skewed view, and co-opts family and friends into your surveillance plans. However noble the intentions, Ring's secretive dealings with the police are starting to look like a step too far, even if it does stop a few Amazon parcels from going missing. **–CL**

Windows May Go Cloud

Microsoft is experimenting with a cloud recovery system for Windows, if a leaked build of the next update is to be believed. It will either offer a cloud download of a complete fresh copy of the latest version, or a "reset locally"' option that reinstalls the existing version. It will require co-operation from hardware vendors, particularly with drivers, and it's no cure-all: You'll still need to get your system to a point where it can get to a cloud server. Microsoft has made no comment as yet, so it may not appear. It does sound like a welcome feature, though. Apple has been offering cloud recovery for a while—having control over hardware has its advantages. **–CL**

Huawei's New OS Ready

After losing access to bits of Google's Android due to sanctions, Huawei has its own operating system, dubbed HarmonyOS. It is completely different from Android, and isn't based on the Linux kernel. It's also only about a thousandth of the size. Initially it will be used to power smart devices such as TVs, speakers, and other IoT gadgets, before jumping to phones if required. It's no Android replacement—it doesn't support Android apps, although all the required SDKs and tools have been released under an open-source license. Huawei faces a tough job to get its home-grown OS effectively running ports of Android apps; there will be an awful lot of APIs to reproduce. **–CL**

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PROJECT ATHENA UNVEILED

Intel sets new standards for mobile computing

SEE THIS LOGO? You'll soon be seeing it appear as a sticker on new machines. Intel has launched its Project Athena, an initiative to improve mobile performance. Manufacturers submit machines for verification, and if they pass, they gain the right to affix the "Engineered for mobile performance" sticker. The requirements cover instant action, performance and responsiveness, intelligence, battery life, connectivity, and form factor.

The idea is to build a consistent experience and capability with mobile devices. Intel has been researching how people use laptops, and what they expect from them. It has identified "key experience indicators" to help measure and guide the process. Most welcome are the requirements for battery power: A machine needs to wake from sleep in under one second, provide 16 hours of battery life playing videos, or nine hours under "real-world performance conditions," meaning running more demanding applications. It also asks for a four-hour charge in just 30 minutes. All good stuff. Hardware requirements aren't too steep: a minimum Core i5, bio-metric login, 8GB of RAM, 256GB SSD storage, Wi-Fi 6, Thunderbolt 3, back-lit keyboard, thin bezels, and 1080p touchscreen.

This is a multi-year project, and this is just version 1.0 of the specs, which will be updated annually as technology improves. The result is you will quickly be able to spot machines with consistent minimum standards. The first Project Athena laptops are currently working their way through the system. The usual big players are co-operating, and the first batch includes the Dell XPS 13 2-in-1, the HP Elitebook 1040, Lenovo Yoga S940, and Acer Swift 5. The scheme is aimed at those who really don't know what's what—the rest of us can read the spec sheet, and peel off the annoying stickers afterward. **–CL**

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TECH TALK

Not All Cores Are Created Equal in Zen 2 Processors

SINCE THE INTRODUCTION of variable clock speeds and boost/turbo clocks, most CPUs have behaved in a similar fashion. The base clock is the minimum guaranteed speed, and the boost is the maximum a CPU can hit—but only in certain situations.

Most of the time, your CPU runs at some in-between clock speed, usually closer to the boost clock than the base clock. However, with AMD's Zen 2 and third-gen Ryzen CPUs, things have changed.

I noticed this while testing, specifically in single-threaded workloads like Cinebench 1T. With most CPUs, such a test would show individual cores hitting the specified boost clock, and one core would always run at 100 percent utilization and the maximum clock speed. In practice, depending on the motherboard firmware and other factors, this isn't always the case, but with Ryzen 3000 CPUs, no core hit—let alone sustained—the maximum boost clock. For the Ryzen 9 3900X, Ryzen 7 3700X, and Ryzen 5 3600X, the highest clock speed my tools showed was 50–100MHz lower.

Others have noted similar behavior, and eventually AMD disclosed more information. In short, the cores in Zen 2 processors are not all rated to hit equal performance levels; there are usually one to three cores that are better than most other cores, and some cores that are worse. In practice, Windows 10 version 1809 (October 2018 update) and later support thread pinning, where the OS schedules single-threaded tasks to the best core. The potential problem is what happens with the other cores—or other OSes.

AMD CPUs appear to have a 75–100MHz gap between the best and worst cores in any given chip. It's related to the binning and chip yields I discussed last month, only now the binning appears to be related to maximum clock speed and voltage for a single core, plus minimum achievable clock speeds of the other cores. With AMD's Precision Boost tech dynamically altering CPU clock speed with a granularity of 25MHz, the cores in a Ryzen CPU run at their maximum individual levels under heavy workloads. However, the sustained all-core clock speeds can and do vary between individual chips.

> Sustained all-core clock speeds can and do vary between individual chips.

This has implications for overclocking—the maximum all-core overclocks are generally 200–300MHz lower than the maximum rated boost clock with third-gen Ryzen (depending on the model). Because overclocking with Ryzen requires users to set all cores to the same target clock speed, performance is often worse when you overclock. Single-threaded workloads run up to 300MHz slower, and even multithreaded workloads may average higher clock speeds without overclocking. It seems that winning the silicon lottery might have more wide-ranging implications than previously.

Third-gen Ryzens have different boost clock behavior from previous Ryzen processors.

It's also important to note that AMD's Zen 2 CPU core behavior isn't entirely new. Intel's enthusiast processors, such as the Core i9-9980XE, have two boost clocks: Turbo Boost 2.0 is the maximum clock speed that each core can reach, while Turbo Boost Max 3.0 is the maximum clock speed for the two best cores. There have also been mobile processors where one or more cores could reach higher clock speeds than the other cores. The difficulty right now is that AMD has no official public statement as to the minimum clock speed of each core with Ryzen 3000. It's at least the base clock, but it could be higher—or it could vary by chip.

This sort of behavior will likely become even more commonplace as processor technology becomes increasingly complex. AMD's change in boost policy may be in part due to the move to 7nm, and as we move toward 5nm and smaller in the future, it makes sense for processors to make the most of the available resources.

Jarred Walton has been a PC and gaming enthusiast for over 30 years.

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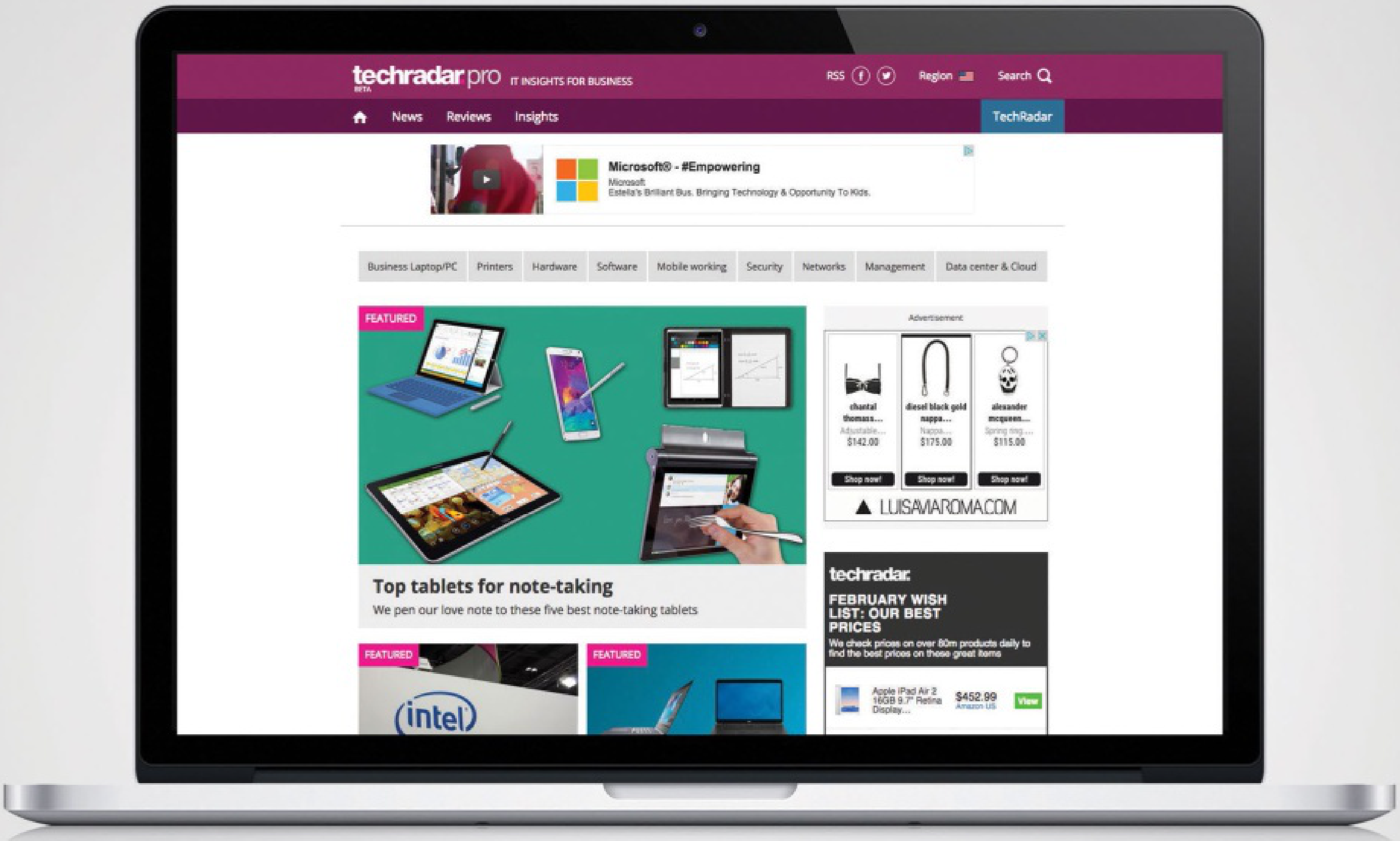
IT INSIGHTS FOR BUSINESS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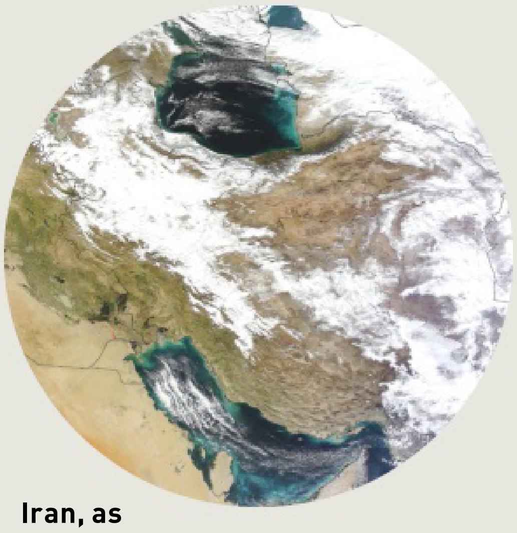
Alex Campbell

OPEN SOURCE

GitHub Shuts the Gates for Sanctioned Countries

WHAT HAPPENS WHEN one of the world's biggest repositories of open-source projects denies access to users based on location? GitHub's new policy can't stop people from Iran or Syria using its services, but it can definitely make it prohibitively inconvenient. And that might be enough.



Iran, as seen from orbit.

In a recent post on its website, the open-source Git repository host GitHub said it would be closing its doors to users originating from countries the United States has sanctioned. Specifically, the ban prevents users from North Korea, Iran, Cuba, Syria, and the Crimea region of Ukraine hosting private repositories with GitHub.com.

For most of the Western world, this doesn't seem to have much impact. After all, keeping North Korea away from code can't be all bad, can it?

While I understand the need for export controls to prevent state enemies acquiring technology, the Internet has made this very difficult to stop. And this isn't the first instance of US law intervening in open source. In 1991, Phil Zimmermann's release of his RSA-based Pretty Good Privacy (PGP) encryption program was considered a violation of the US Arms Export Control Act by the US Customs Service, and considered a munition. Of course, PGP (largely implemented through GnuPG) is used by most Linux systems in the wild today. The open nature of the program made it difficult to control, because once the source was available online, there is little that can be done to stop its spread.

While Zimmerman and PGP is a good case to use as reference, GitHub's move doesn't attempt to stop open source, but the use of its platform. That's an important distinction, especially as public repositories will still be available in sanctioned countries. In fact, GitHub's new terms have little to do with controlling the use of open source in sanctioned countries; organizations in those states can still spin up some GitLab servers and get many of the same features. What does draw a little attention is the details of implementation.

> Drawing borders in the inherently borderless Internet is tough, even for state actors.

Drawing borders in the inherently borderless Internet is tough, even for state actors. Famously, the Chinese firewall is an attempt to isolate mainland Chinese users from using Western news and social media. Dedicated Chinese users use VPNs to skirt the government's digital barrier.

GitHub says that it will use IP addresses and billing information to block access to users in sanctioned countries. For those keeping score at home, location data from IP addresses can be easily hidden using a proxy or VPN. GitHub addresses this by saying that use of proxies or VPNs by users from sanctioned countries is a violation of its rules. It would be a very tough job to try to enforce this.

By their very nature, VPNs hide the identities of their connected clients. The first thought of how Microsoft and GitHub could block VPN use is by blacklisting VPN provider IP addresses. Such a move would have the obvious unintended consequence of preventing non-sanctioned users accessing the service via VPN. This has the potential to trample on legitimate VPN use: Traveling users who use open Wi-Fi networks use (or should use) VPNs to protect their internet traffic from a snooping Wi-Fi or internet service provider. Even then, it is trivial to spin up an OpenVPN server on a virtual private server (VPS) provider.

Trying to catch every user who tries to skirt the Eye of Sauron will likely prove to be futile for all but the most careless users. That said, the policy makes sense. GitHub is now owned by Microsoft, and Microsoft provides a lot of services to the US government. If Tehran kept code for state projects on GitHub, which is owned by a company that also contracts with the US Defense Department, it definitely wouldn't be a good look.

Alex Campbell is a Linux geek who enjoys learning about computer security.

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THE LIST

8 BEST WEBCAMS AVAILABLE RIGHT NOW

8

RAZER STARGAZER

A depth-sensing webcam that supports nifty features such as head-tracking, this is a camera for the professional streamer looking for high-end hardware. Sadly discontinued by Razer, but still available online.

7

LOGITECH C310

A cheap and cheerful option, the Logitech C310 is a great choice if you're just a casual webcam user, only interested in the occasional Skype call to Mom and Pop.

6

CREATIVE LABS BLASTERX SENZ3D

The most expensive webcam here, Creative Labs' BlasterX uses three lenses and Intel's RealSense tech to respond to facial expressions and body gestures.

5

LOGITECH BRIO ULTRA HD

Essentially the polar opposite of the C310 above, the Brio is Logitech's high-end offering. Perfect for streamers, it comes packing background-replacement technology and 60fps recording.

4

ANIVIA W8

Frequently on sale, the fun-size W8 is a good general-purpose webcam. It's almost suspiciously simple to set up and use, too. It's also a solidly built device.

3

MICROSOFT LIFECAM HD-3000

With a noise-canceling microphone and miniature design, the HD-3000 is a great budget offering from Microsoft. It easily attaches to both laptop screens and desktop monitors as well.

2

RAZER KIYO

The ideal webcam for professional streamers, the Kiyo comes equipped with a ring light, ensuring that your thousands of fans can see you even in the gloomiest gaming room.

1

LOGITECH C920

Logitech is dominating this list, in case you didn't notice. A great middle-ground webcam, the C920 provides good performance without a demanding price point. It's often on sale, too.

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HEAD TO

BY **CHRISTIAN GUYTON**

RX 5700 XT vs. RTX 2060 Super vs. RTX 2070 Super

With both AMD and Nvidia pushing their new GPUs, what better to do than pit them against each other? Looking at the five new cards available and forced to pick just three, we decided to focus on those that occupy the middle ground: the Radeon RX 5700 XT in the red corner, and the GeForce RTX 2060 Super and 2070 Super repping for the green team. It's worth noting before we start that all three are awesome 1440p GPUs, although that's not really in the spirit of the "Head to Head," so instead, three cards enter, one card leaves....

ROUND 1

Value

The GeForce RTX 2070 Super is a fantastic refresh of the original 2070, providing better performance for the same price. Unfortunately, that original price is a bit steep when compared to the other two cards here—always upward of $500. Compared to the RX 5700 XT, which costs an even $400 and comes very close to matching the 2070 Super in our 1440p ultra tests, it's a no-brainer: The 5700 XT is simply the better card when it comes to bang for your buck. The 2060 Super doesn't have much of a chance here either—while it's priced at $400, too, the performance is below that of the 5700 XT in the vast majority of games.

That said, it's worth considering the factory-overclocked models that are available. Because the premium you pay for a quality factory-overclocked card scales with the original price of the card, the 2070 Super is once again cut out of the running here. The 2060 Super is almost in with a shout, thanks to some admittedly excellent models from the likes of EVGA and MSI, but the 5700 XT has some good-value overclocked cards, too, and ultimately the difference simply isn't enough to swing the jury (that's us—we're the jury).

Winner: RX 5700 XT

ROUND 2

Efficiency

A recent statement from AMD revealed that the potential operating temperatures for the RX 5700 XT could—somewhat alarmingly—reach as high as 110 C, thanks to an enhanced thermal monitoring system introduced in the Radeon VII card. While that might be good news for overclockers, it's not so great for anyone who wants an efficient, quiet system. The single fan on the baseline model runs quite loudly under load, and the power draw is fairly monstrous, too, at 225W. That's a whole 10W more than the RTX 2070 Super, which is an ostensibly more powerful card. Considering that the performance at 1440p is slightly inferior to that of the 2070 Super, AMD is sadly kicked out of this bout.

AMD cards have always had issues with power management compared to Nvidia, typically guzzling more system power than similar cards from the green giant. The RTX 2070 Super is relatively demanding, but it's a more powerful card. The 2060 Super, on the other hand, has a TDP of a paltry 175W, making it by far the most energy-efficient card we're looking at here. We could look at the Super cards in terms of noise and heat production, but the 2060 Super and 2070 Super are relatively close there anyway, so we have a clear winner.

Winner: RTX 2060 Super

ROUND 3

Overclocking

Unsurprisingly, the 2060 Super struggles to be competitive in this area. Its boost clock is stated by Nvidia to be 1,650MHz—only 45MHz faster than the base clock on AMD's RX 5700 XT, despite sharing the same price tag. So, it's between the 5700 XT and the 2070 Super, then.

AMD has muddied this process with its new inclusion of a "game clock" figure, supposedly representing an operating overclock for most games. In reality, this figure is quite restrained, and many games will make the GPU clock higher anyway. The reported maximum boost clock on the 5700 XT is a very impressive 1,905MHz, compared to the 2070 Super's more conservative 1,770MHz. It would be easy to declare the 5700 XT the winner here, but looking at manual overclocking tells a different story.

The superior thermal design and lower TDP mean that the 2070 Super is a lot more receptive to manual overclocking. The stock cooler on the 5700 XT holds it back; if you're a dedicated tinkerer, you might be able to squeeze superior performance from it via liquid cooling, but otherwise the 2070 Super is easier to overclock. This is the first time for a while that AMD has been able to properly match pace with Nvidia in the overclocking department, though, so we'll call it a tie.

Winners: RX 5700 XT and RTX 2070 Super

RADEON
RTX 2060 super
RTX 2070 super

From left to right: The RX 5700 XT is still kinda ugly.

Nvidia's current budget card, the 2060 Super, fails to impress here.

Triple-fan units are available for the 2070 Super, but we didn't test with that.

ROUND 4

Performance

Unlike the last time we looked at GPUs here, all three of these cards pack the same amount of VRAM: eight gigs of it, to be exact. The speed is the same, too: 14GT/s, across the board. As such, we're forced to pay more attention to the architecture of the cards, considering CUDA cores and texture units. Looking at the raw numbers here, the RTX 2070 Super should be a clear winner.

So, on to the benchmarks. As predicted, the 2070 Super dominated in almost every game we tested, with only a handful of games favoring AMD. The differences are frequently quite close, however, barring the 5700 XT's apparent panic attack when we tried to test *Middle Earth: Shadow of War*. These figures will likely fluctuate a little as both AMD and Nvidia release updated drivers for their cards, but it's safe to say that the best performance is provided by the 2070 Super.

In a wider selection of games, the 5700 XT only lags behind the 2070 Super by an average of three frames per second at 1440p ultra. The 2060 Super, on the other hand, sits 11fps behind its big brother on average—though still comfortably within a good range for 1440p gaming.

	RX 5700 XT	RTX 2060 Super	RTX 2070 Super
Tom Clancy's The Division 2 (fps)	69/58	64/51	**78/66**
Assassin's Creed Odyssey (fps)	54/43	53/42	**57/44**
Far Cry 5 (fps)	**103/86**	90/73	**103**/79
Shadow of the Tomb Raider (fps)	**97/75**	82/62	93/67
Middle Earth: Shadow of War (fps)	70/24	73/53	**83/61**
Metro Exodus (fps)	65/37	56/33	**67/38**
Total War: Warhammer II (fps)	67/47	76/58	**83/61**

Best scores in bold. Our test bed consists of an Intel Core i7-8700K, 16GB of G.Skill DDR4-3200, a Gigabyte Z370 Aorus Gaming 7, and a 1TB Samsung 970 Evo M.2. All games are tested at their highest graphical profile with AA turned on at 1440p. Figures provided are an average and a minimum (97th percentile) respectively.

Winner: RTX 2070 Super

And the Winner Is…

It's the RTX 2070 Super, but only just. Looking at the scores, we saw one point in favor of the 2060 Super, then two points each for the 5700 XT and 2070 Super. Ultimately, we decided that performance was more important than value, but that's a very significant caveat: If you've got limited funds, but want to game at 1440p, the RX 5700 XT might be best. It's a high-quality card that stomps the similarly priced 2060 Super into a fine paste.

The fact remains, though, that the 2070 Super is the superior GPU. Great 1080p and 1440p performance and a variety of excellent factory-overclocked models mean that if you've got $500 to drop on graphics, this is the card you need. The original 2070 was a quality card, but this is a step up; performance that outstrips its predecessor without doing any more damage to your wallet.

Tragically, that means that the poor old 2060 Super is left out in the cold. It's not a bad card by any means—don't get us wrong—but it lacks the performance and value of the other two, which really makes it hard to recommend, unless system power is something you're trying very hard to minimize. And if you are doing that, why? ⏻

DOCTOR

THIS MONTH THE DOCTOR TACKLES...

> Storage Spaces
> Audio Anomalies
> Disturbed Sleep

Storage on the Move

Hi Doc, I'm preparing to build a new PC and plan to reuse my two 3TB hard drives. They're currently mirrored in Storage Spaces. Is there an easy way to move them, or do I have to back them up, move the drives, and rewrite the data?

I also have Adobe InDesign CS5. Adobe supported this for a generous amount of time with patches and enhancements but doesn't anymore. If I install it off the CD, then copy all the files from the current installation to the new one, will I be back where I am now? Or do you know a clever way to move old apps? **–Michael Duval**

For modern performance at a mainstream price, the Radeon RX 5700 offers plenty of value.

© AMD

THE DOCTOR RESPONDS: If your 3TB drives are already working well under Windows, then making the switch to a new platform should be as easy as disconnecting them from your old machine, hooking them up to the new one, and checking Storage Spaces to make sure they've been recognized properly. Get Windows installed on the new build before switching over. And check that the drives are set up similarly in both BIOSes. If they're currently configured in AHCI mode, carry that over to minimize the potential for conflicts.

Just to be sure this works, the Doctor built two PCs in the lab, one with a Core i7-7700K and another with a Core i7-8086K, both running Windows 10 Pro 1903. He created a two-way mirrored storage pool on one, shut that system down, and moved the drives to the other machine. Windows picked them right up as the same storage space.

With regard to InDesign CS5, get your copy of the software installed using the CD, then visit https://adobe.ly/2YrUUPk. That page contains all of the InDesign downloads available for Windows, dating back to the very first version.

Shot in the Dark

Hello Doc. I built my PC eight years ago in a Cooler Master HAF X with a Core i7-2600K, an Asus P8P67 EVO motherboard, 16GB of G.Skill low-voltage DDR3L-1600 memory, and an Asus Strix GeForce GTX 970. This was the first machine I ever pieced together, and it has served me well, but it's time for something new. What do you suggest? I'd like to keep my budget to about $1,000.

Another issue I'm having is that my system crashes randomly. If I could fix this, maybe I wouldn't have to upgrade. The issue isn't limited to a specific program or website. Rather, any time there is a song playing, the screen freezes and I hear one high-pitched note that continues until I shut everything down. The light on the keyboard turns off and it stops responding. For a long time, I thought the problem was my motherboard, but nothing I've tried works. It has been suggested that I download the newest driver for my graphics card. Even then, my PC keeps crashing. Can you help? Is it the motherboard, GPU, or memory?

One last question: How long is thermal paste good for? Does it need to be reapplied every so often?

Glad to see the team at *Maximum PC* doing well. I have a subscription that should last for two more years, and I plan to continue receiving the magazine in print. Great job, everyone!

–Kirk Andrews

THE DOCTOR RESPONDS: The purpose of thermal interface material (TIM) is to fill the tiny pits and gaps between the mating surfaces of your CPU's heat spreader and the sink sitting on top of it, displacing air that would otherwise act as an insulator. So long as the TIM was applied properly, it shouldn't need to be reapplied unless the seal between those surfaces is broken. Still, it wouldn't hurt to monitor the temperature of your Core i7-2600K and make sure it isn't

↘ submit your questions to: doctor@maximumpc.com overheating. Head to https://bit.ly/2zveela and download Core Temp, which allows you to read each core's thermal sensor, and ensure temps don't climb too high.

Because your issue is related to audio playback, heat probably isn't the culprit. Instead, there's a long list of possible hardware and software sources to explore. Failing PSUs, problematic motherboards, RAM on the fritz, and overclocked CPUs are all potentially to blame. Bad BIOS settings, graphics card driver bugs, and audio codec problems land on the troubleshooting checklist, too.

Make sure you're running BIOS version 3602 for your P8P67 EVO. Nvidia is still updating the drivers for your GeForce GTX 970, so check you're using the latest version on its website. Grab the latest driver package for Realtek's ALC892 on Asus's support page. Get Windows as up to date as possible. And uninstall any apps you don't use.

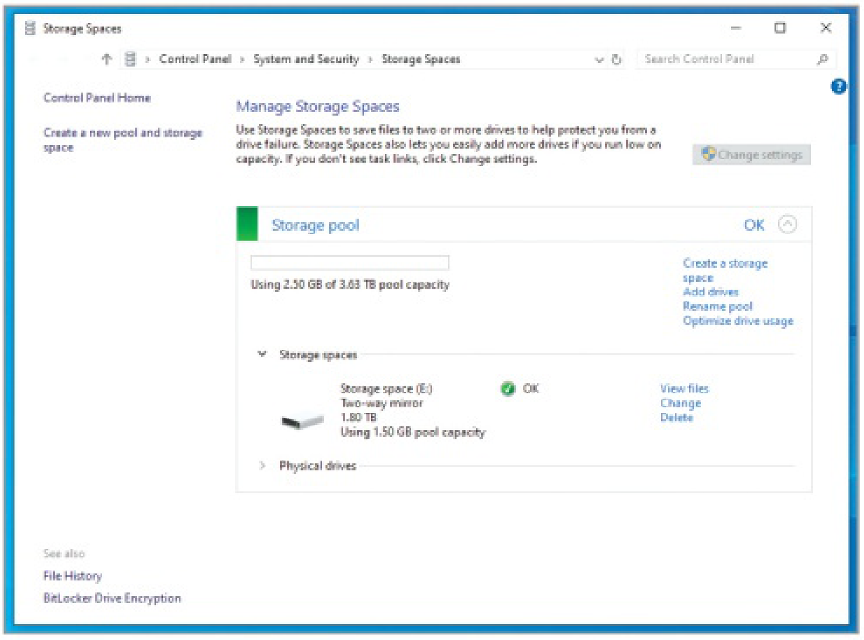
If all else fails, it might be time to start replacing hardware. Upgrading from a Core i7-2600K is going to require a new motherboard, CPU, and RAM. A newer PSU probably wouldn't hurt, and there's a fair chance you'll want a graphics card and storage subsystem to match. It should be possible to put together a machine with a six-core AMD Ryzen 5 3600X CPU and corresponding motherboard, 16GB of DDR4 memory, a Radeon RX 5700 graphics card, a large SSD, and a 650W or 750W power supply for under $1,000.

Sleep Disturbances

Dear Doctor, I have a B450 Aorus Elite motherboard and a Ryzen 7 1700X in a PC I built last year. I intend to upgrade to a Ryzen 3000-series CPU, but know I need to update the board's BIOS first. The Aorus support site said I'd need to flash an intermediate build in order to tweak the Q-Flash utility so that it would accept the newest firmware. I went through the steps, upgrading from version F2, published 8/15/2018, to version F32, published 5/6/2019. I made no other changes to the configuration, and expected no change of functionality.

Normally, I put Windows to sleep rather than shutting my PC down, preserving the state of the apps I leave open. This worked flawlessly until I flashed BIOS F32. Since then, the sleep function works eventually, but never the way it used to. Now there's a long pause after hitting the key to wake my system up. 20 percent of the time or so I get the Windows wallpaper for the login screen, followed a few seconds later by a blue screen. The stop code is usually "System Service Exception," but I've occasionally seen "Kernel Data Inpage Error," "Unexpected Store Exception," or "Critical Process Died." Then the machine reboots and displays the BIOS message described below.

80 percent of the time, I get no Windows wallpaper or blue screen. In either case, I wind up with a message from the BIOS that says "Reboot and Select Proper Boot Device or Insert Boot Media in Selected Boot Device and Press a Key." If I press a key, punch in Ctrl-Alt-Del, or hit the reset button, I get the same BIOS message again. But if I hold the power button down for five seconds and then fire everything back up again, I get a login screen that recovers from sleep mode. All my apps are reinstated. This takes a couple of minutes to get through, however, when it used to take 10 seconds. If I simply shut down, there is never an issue rebooting.



Use Storage Spaces to save files to two or more drives to help protect you from a drive failure. Storage Spaces also lets you easily add more drives if you run low on capacity. If you don't see task links, click Change settings.

Using 2.50 GB of 3.63 TB pool capacity

Storage space (E:)
Two-way mirror
1.80 TB
Using 1.50 GB pool capacity
OK

You should have no problem moving hard drives that have been configured through Storage Spaces to another PC.

I would not expect the PC to wake up from sleep after completely powering off. That should be forcing a clean reboot instead, right? I thought the sleep feature relied on memory contents remaining intact. Or did this change when the "hibernate" option was removed?

I cannot come up with an explanation for what could be causing this. If it were really the case that the proper boot device was not selected, my machine would never work, so the BIOS must be misreporting the actual error. Also, if it were scrambling the boot device, I would never see the Windows wallpaper and blue screen appear some of the time. This is a real head-scratcher.

Do you have any ideas? I built my first computer, an XT clone with a blazing 10MHz NEC processor, in 1985, and have built dozens since with only the occasional mishap. I mostly use Intel CPUs but have chosen AMD when that seemed a better option. I've been a subscriber for years and always use your magazine as a guide for selecting new components.

–Joe Binter

THE DOCTOR RESPONDS: It sounds like you successfully made the jump from a really old BIOS version (F2) to a much newer one (F32). Before taking the next step to F40 or F41, you must install the EC FW Update Tool (https://bit.ly/2YxHMvX), which allows the motherboard to support memory training on the new Ryzen 3000-series CPUs. After updating the firmware, you can flash BIOS version F40 (with AGESA 1.0.0.2) or F41 (with AGESA 1.0.0.3 AB). Then it'd be a good idea to load the factory default settings and get your BIOS reconfigured.

Also, did you notice that Gigabyte recommends updating AMD's chipset driver to 18.10.20.02 before flashing to F4 and then version 18.50.16.01, before writing F30 to your B450 Aorus Elite? Even if you haven't upgraded your CPU yet, try uninstalling whichever version of the chipset driver you're using and replace it with the latest build from AMD.

If Windows still isn't behaving, jump back into your BIOS and start looking for settings that might have changed between F2 and F32. For example, tab over to the "Power" menu and scroll to "Soft-Off by PWR-BTTN." By default, this should be set to "Instant-Off," which shuts your system down when its power button is pressed. If it's set to "Delay 4 Sec," it takes a four-second button press to turn your PC off. Hitting the power button for fewer than four seconds puts the machine into suspend mode.

The Doc can't say for sure why your symptoms are so sporadic, but he hopes that using the latest BIOS, AMD's newest chipset drivers, and build 1903 of Win 10 helps iron out the inconsistencies you are experiencing.

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WINDOWS MADE FRESH

Ready to reinstall Windows? Are you really? Let's look at your options... *By Alex Cox*

crucial
by Micron
2.5-inch SOLID STATE DRIVE
PNY
SOLID STATE DRIVE
AD
Ultimate
Solid S
SU

SO, YOU USE WINDOWS. You're in a slowly shrinking but still three-quarters majority, so it's not a surprise: Windows users are ubiquitous. Almost as ubiquitous as people complaining about Windows, because that group extends to macOS and Linux users, too. Whatever your gripes, the thought of reinstalling Windows has likely crossed your mind at some point. Perhaps you've even gone ahead without thinking of the consequences. You might even have been left with a half-functioning machine that's missing many of your critical files and programs. Let's be clear at the start of this feature (one that's ostensibly about reinstalling Windows): Reinstalling Windows is generally a really dumb thing to do.

Hear us out. Windows 10 is a much cleaner and more stable OS than its predecessors. There's no good reason to reinstall it unless you've managed to screw with its system files to the point of oblivion, or you've fallen victim to some serious malware that can't be expunged in any other way. If you're in the latter bracket, it's probably too late for your files—unless you've taken the correct precautions. With a proper process built into your everyday computer use, reinstalling is trivial and safe. Mostly pointless, but clean enough.

So, you could reinstall Windows, and we'll talk about it in detail, but we'll also show you other options. Before you throw everything away and start over, perhaps you'll want to clean everything up manually, or use Windows' own refresh tools, to leave your current installation in a better state. Maybe you'd like to try an innovative (and slightly silly) dual-boot, putting a clean Win 10 alongside your dirty one. You could be moving machines, and want to turn a fresh install on your new hardware into something akin to your current PC. It all sounds easy, but proper procedure is essential if you want to keep everything precious.

1 REINSTALLING FOR FUN & PROFIT

REINSTALLING WINDOWS 10 is a fairly trivial task. Put in the right media, boot from it, grind away the old OS, and replace it with the pristine bits of a shiny new install. This can be a painless if time-consuming procedure that leaves you with a like-new PC, or perhaps an even better one if you were unlucky enough to buy a PC burdened with preinstalled trashware. We permit you to do this as long as you've checked off a few prerequisites, all of which are good practice even if you're not planning to wipe everything and start again.

First, keep a record of your product key (if you have one—most likely if you've upgraded from a previous version of Windows), or make sure your digital license is well looked after. If you've bought a PC in the last few years, you're probably using a digital license rather than a key. Check "Settings → Update & Security → Activation." If you see the message "Windows is activated with a digital license," this means you're digitally signed, but you should link that license to your Microsoft account in case of installation issues or future hardware changes. Head to "Settings → Accounts → Your Info," sign in with your Microsoft account details, and the message should change to "Windows is activated with a digital license associated with your Microsoft account."

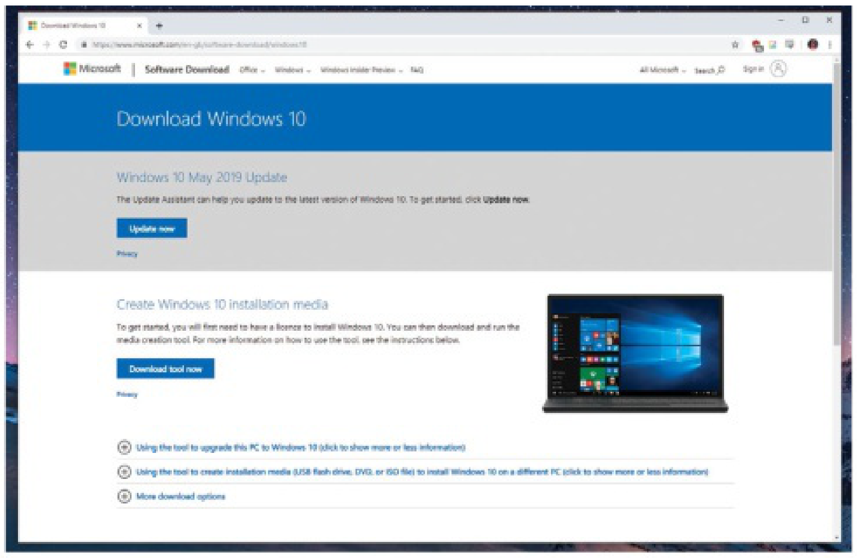
KEY INFORMATION

Next, dig out the keys for all your crucial software and keep them safe, as you'll need to reinstate everything manually when performing a full reinstall. You can use PowerShell to make a list of your installed programs; launch it as administrator and type:

```
Get-ItemProperty HKLM:\Software\Wow6432Node\Microsoft\Windows\CurrentVersion\Uninstall\* | Select-Object DisplayName, DisplayVersion, Publisher, InstallDate | Format-Table –AutoSize > C:\software.txt
```

A list is output to the "software.txt" file in the root of your C drive. Tweak if you want a different file name or location. Keep a copy of this elsewhere, in case you come to your reinstalled machine and realize there's something you've forgotten. If you want to make your job easier, ProduKey (http://nirsoft.net) can dig up keys for many Microsoft apps and Windows; also consider using a lockable password manager, such as LastPass (www.lastpass.com), to not only keep a record of logins, but to store details about your software so it's always there when you need it.

You can't back up programs (Windows' file structure doesn't work like that), but you can (and should) back up every other little



Download Windows 10

Windows 10 May 2019 Update

The Update Assistant can help you update to the latest version of Windows 10. To get started, click **Update now**.

Create Windows 10 installation media

To get started, you will first need to have a licence to install Windows 10. You can then download and run the media creation tool. For more information on how to use the tool, see the instructions below.

Microsoft
Software Download
Update now
Privacy
Download tool now
Privacy
Using the tool to upgrade this PC to Windows 10 (click to show more or less information)
Using the tool to create installation media (USB flash drive, DVD, or ISO file) to install Windows 10 on a different PC (click to show more or less information)
More download options

Microsoft is happy to dole out the code for Windows 10, but you'll need a proper license if you want to use it fully.

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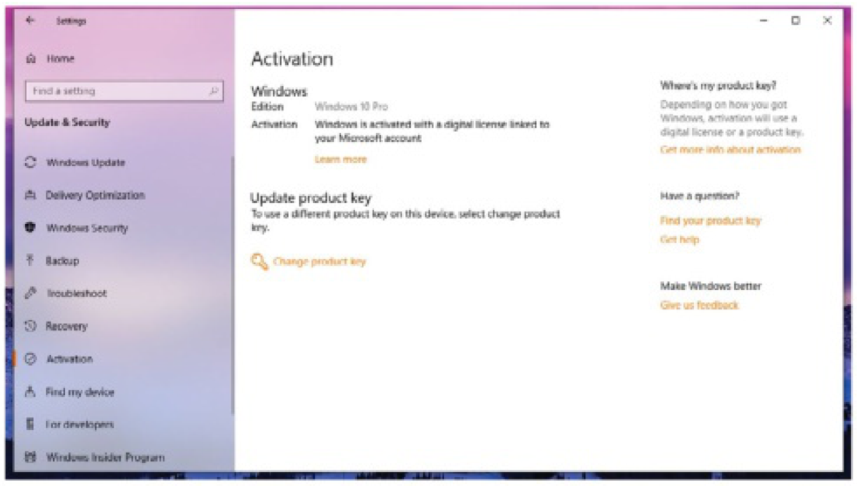


Activation

Windows
Edition Windows 10 Pro
Activation Windows is activated with a digital license linked to your Microsoft account
Learn more

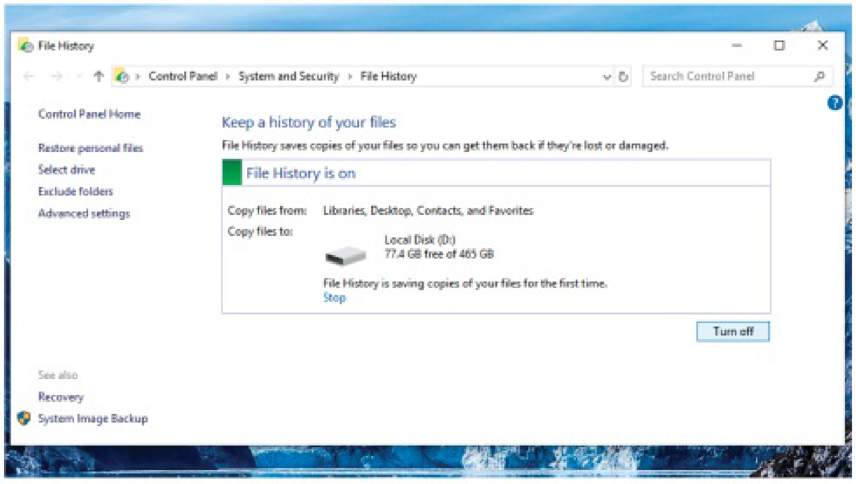
Update product key
To use a different product key on this device, select change product key.
Change product key

Where's my product key?
Depending on how you got Windows, activation will use a digital license or a product key.
Get more info about activation

Have a question?
Find your product key
Get help

Make Windows better
Give us feedback

Ensure your license key is properly linked to your Microsoft account before you begin reinstalling Windows.



Keep a history of your files
File History saves copies of your files so you can get them back if they're lost or damaged.

File History is on
Copy files from: Libraries, Desktop, Contacts, and Favorites
Copy files to: Local Disk (D:)
77.4 GB free of 465 GB
File History is saving copies of your files for the first time.
Stop

File History isn't just about keeping versions—it's about keeping everything, and can be a real lifesaver.

thing. Backing up your hard drive using something like Macrium Reflect might seem like a solid idea, and it's the best way to make sure you don't miss anything, but a compressed copy won't give you access to the files you need once it's made, and it's pointless if you're reinstalling to fix a broken system—instead, consider Windows File History to perform rolling backups of crucial folders as you use your machine. It's slow to start, but if this is something you set up to run invisibly as you use your PC (and, ideally, back up to different hardware periodically), you always have a backup ready when you need one. Try to include driver installation files in your personal folders, to be caught by File History—and consider creating a second, manual backup of all of your important files. Check them both for integrity before you pull the trigger.

One last consideration: DRM. It's a menace, but never more so than when you have a bunch of DRMed files that are tied to an account that limits PC authorizations. Kill your current install, and you might not be able to get that authorization back—you could even lose access to all the things you've bought; DRM is cruel like that. So, make sure any management app, such as iTunes, has been de-authorized before you leave your current install behind.

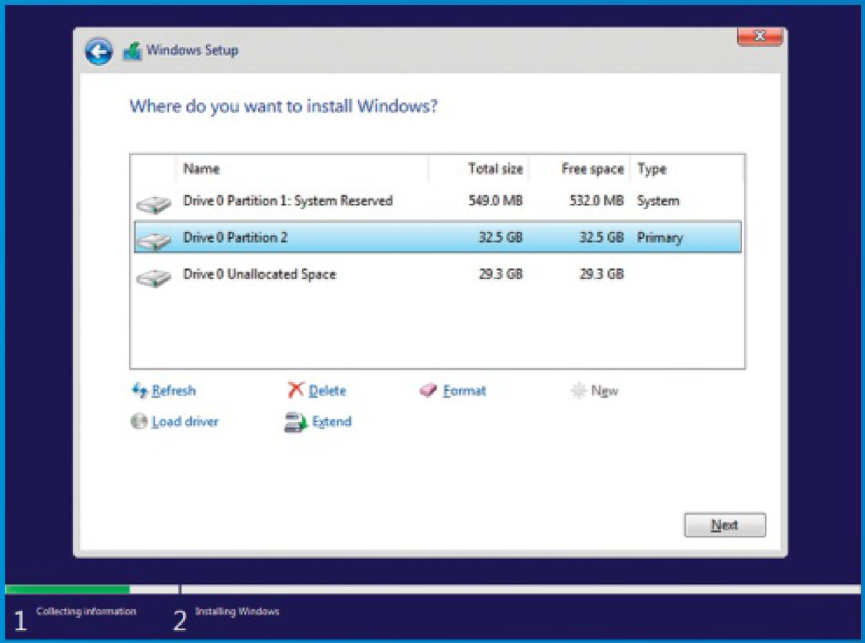
INSTALLATION ART

With all this done, go ahead and reinstall. You can create your own installation media by heading to www.microsoft.com/en-us/software-download/windows10 and using the media creation tool to put the latest update of Windows 10 on a USB stick ready for installation. You don't need us to walk you through a Windows install by now (it's not particularly difficult), but a couple of notes: You'll want to select "Install Windows Only," because the "Upgrade" option will leave your PC basically as it was; and you can skip inserting a product key—you can do this later, or your PC will activate itself when you sign in to your Microsoft account.

MULTIBOOTING WINDOWS 10

One of the factors that contributes to our pessimism surrounding reinstalling Windows is that we desperately don't want you to lose anything. We're kind like that. But there is another, slightly frivolous way to do a reinstallation if you've got working hardware to play with: You can turn one Windows installation into two. If you have a second drive that is able to support a Windows 10 installation, or enough access to your current Windows 10 installation (and enough free space) to be able to trim down its drive using Disk Management then create a new clean partition, you can install a second copy of the operating system alongside the first. Simply select a custom install, and then point Windows 10 at that spare disk space—it should do the rest for you.

It's slightly questionable whether you'd technically need a second Windows license to do this—you can only possibly use one instance of Windows 10 at a time if installed this way, so it shouldn't be an issue, but the Microsoft EULA does suggest that only one instance is allowed to exist, so take that as you will. You'll likely need to switch off BitLocker before partitioning your drive, and if you use Windows in this way, you'll want to do this anyway, since an unlocked filesystem on your original install can be easily accessed on your new one. Copy everything to a safe new location, make sure you've got everything, and you can ditch the original install—and if you're likely to use the new installation as your main copy of Windows, you'll need to make sure it's first in the boot order. It should be by default, but you may need to poke around in your BIOS/UEFI settings to select the correct drive, or set it through the "Advanced" system settings link from the Control Panel's "System" tab.



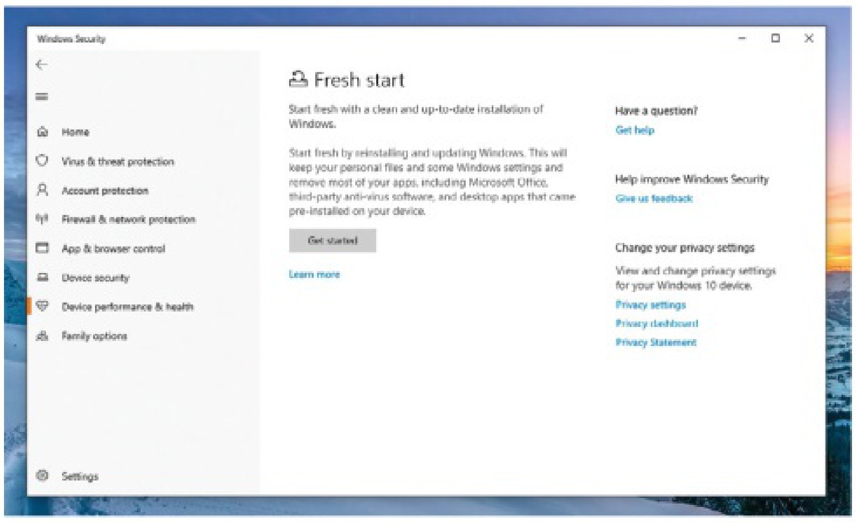
Where do you want to install Windows?

Name	Total size	Free space	Type
Drive 0 Partition 1: System Reserved	549.0 MB	532.0 MB	System
Drive 0 Partition 2	32.5 GB	32.5 GB	Primary
Drive 0 Unallocated Space	29.3 GB	29.3 GB	

Just select the correct partition and install away. But make sure it definitely is the correct one before you start.

2 REFRESH, RESTART, RECYCLE

IF YOU'VE GONE TO THE TROUBLE of creating new installation media for any version of Windows 10 past the Creators Update, you'll probably feel a bit silly when you discover that Microsoft tucked a "fresh start" option into its later Win 10 editions. Using it takes any Windows 10 installation back to the basics of a Windows install, even removing any preinstalled software your manufacturer might have included, and stripping away all your drivers—and it doesn't require any special media. It's basically a clean install without you having to directly perform the actions of reinstallation. You'll find it in a corner of Windows Defender Security Center, aka Windows Security—select "Device performance and & health," then "Additional info," before clicking "Get started" to begin. Again, make sure you're backed up, as this is only slightly less destructive than formatting your hard drive. Handily, the fresh start procedure leaves a little note of all the things you've destroyed on your desktop, just so you can kick yourself for reinstalling after we told you it was a bad idea.


Windows Security
Home
Virus & threat protection
Account protection
Firewall & network protection
App & browser control
Device security
Device performance & health
Family options
Settings
Fresh start
Get started
Learn more
Have a question?
Get help
Help improve Windows Security
Give us feedback
Change your privacy settings
Privacy settings
Privacy dashboard
Privacy Statement

Start fresh with a clean and up-to-date installation of Windows.

Start fresh by reinstalling and updating Windows. This will keep your personal files and some Windows settings and remove most of your apps, including Microsoft Office, third-party anti-virus software, and desktop apps that came pre-installed on your device.

View and change privacy settings for your Windows 10 device.

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Aaah, a fresh start. What could be better? Not losing all the software you've installed over the years, that's what.

PRESS RESET

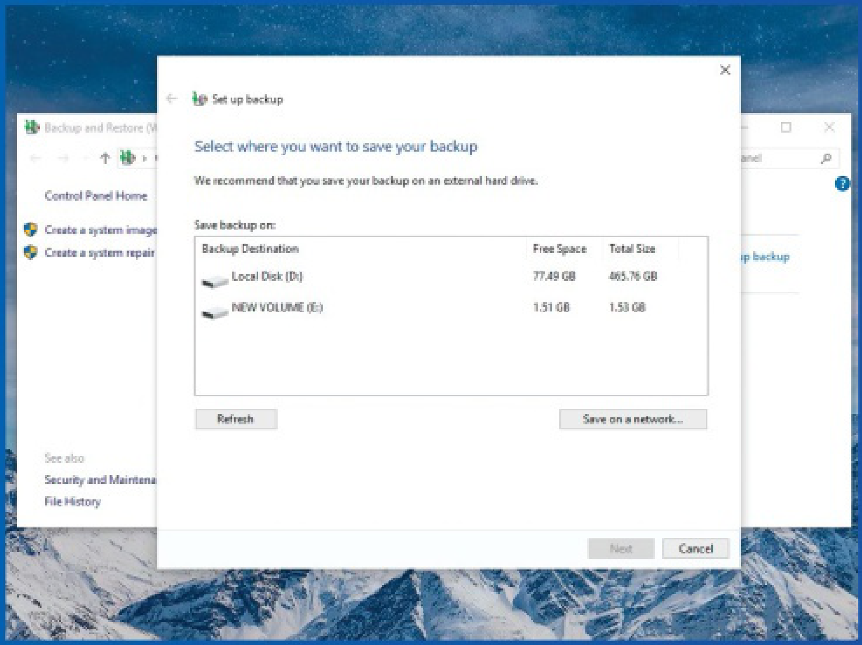
A better option might be to take advantage of Windows 10's "reset" feature, which strips out all of your installed applications and drivers while giving you the option of leaving your personal files unmolested. This doesn't mean you can get away with not using proper backup procedures, but if there's a particular software component causing you problems, this will very likely get rid of it. Basically, it rolls your machine back to the state in which it came to you: preinstalled software, drivers, and all. You might remember that earlier editions included two options, the confusingly different "reset" and "refresh"—they're squashed together into this less baffling new procedure. It does, technically, create a fresh installation of Windows, rather than uninstalling anything, as while it's running through, it uses the Windows Recovery Environment and sections off your personal files, putting them back where they were if you choose to keep them.

If you're insistent on reinstalling, perhaps you'd like to consider an upgrade? Not a version upgrade as such, but an in-place

BUILDING BETTER BACKUPS

Reinstalling is, or should be, a last resort—and if you ever come to the point where you absolutely have to reinstall Windows and don't have copies of your files, it might be too late. A hardware failure, a cryptographic malware attack, whatever the case may be, you don't want to be left stranded. We've talked about using Windows' File History tools elsewhere, which is a good way to keep regular copies of your personal files, but Windows also includes a more thorough backup procedure in the form of Backup and Restore (Windows 7). Now, we can't be entirely sure how long this is going to last, given its archaic name, but for now, it works, and we'd wager that Microsoft will supply a tool to restore its backups even if the facility gets removed from future versions of the operating system. If you have a backup on an external drive, you can reinstall Windows from scratch and restore it using the same tool—aim to make one every week or so, so you don't lose too much time. EaseUS Todo Backup 11 Free (www.easeus.com) is a decent option for automating backups; make sure, if you do this, that you don't leave your backup drive permanently connected to your machine, because a hardware failure passed down the line is a double whammy of disappointment.

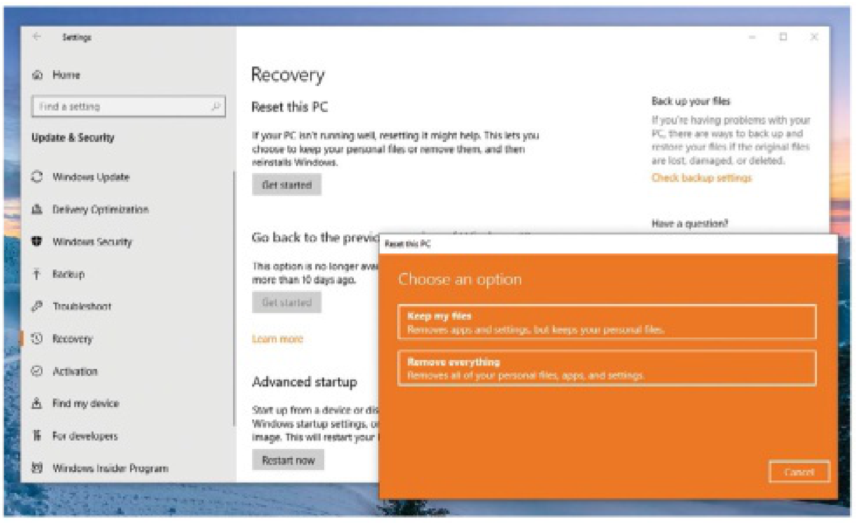
Do not discount the power of system restore points, either. While they're not kind to storage—we'd put them on your mechanical long-term storage drive, rather than an SSD, if you have the choice—making a system restore point regularly is good practice. Taking the overkill position of making one before installing anything even slightly questionable is an even better thing to do, although we don't really expect you to do that. Make sure you clean up when you're sure your machine is running fine, because a huge hoard of system restore points does nobody any good.


Backup and Restore (W
Control Panel Home
Create a system image
Create a system repair
See also
Security and Maintena
File History
Set up backup
Select where you want to save your backup
Save backup on:
Refresh
Save on a network...
Next
Cancel

We recommend that you save your backup on an external hard drive.

Backup Destination	Free Space	Total Size
Local Disk (D:)	77.49 GB	465.76 GB
NEW VOLUME (E:)	1.51 GB	1.53 GB

It's an older tool, sir, but it checks out.



Settings
Home
Find a setting
Update & Security
Windows Update
Delivery Optimization
Windows Security
Backup
Troubleshoot
Recovery
Activation
Find my device
For developers
Windows Insider Program

Recovery

Reset this PC

If your PC isn't running well, resetting it might help. This lets you choose to keep your personal files or remove them, and then reinstalls Windows.

Get started

Go back to the previo

This option is no longer ava
more than 10 days ago.

Get started
Learn more

Advanced startup

Start up from a device or dis
Windows startup settings, o
image. This will restart your

Restart now

Back up your files

If you're having problems with your PC, there are ways to back up and restore your files if the original files are lost, damaged, or deleted.

Check backup settings
Have a question?
Reset this PC

Choose an option

Keep my files
Removes apps and settings, but keeps your personal files.

Remove everything
Removes all of your personal files, apps, and settings.

Choosing the reset option enables you to immediately select whether to keep your files or not.

upgrade install—running through the Windows 10 install process, throwing fresh copies of all critical system files on to your PC, but leaving everything else, including software, as is. Opting to do this can (in theory) fix certain issues with your machine, and it's particularly effective against those problems that standard Windows prodding techniques don't solve. To perform an in-place upgrade, you need to be logged into an administrative account, have a good chunk of disk space free, and have secure boot switched off (at least temporarily) in your UEFI settings.

Use the Windows 10 Media Creation tool (see above) to create a USB stick, but don't boot from it: Open the drive from within Explorer, right-click the "setup.exe" file, and opt to run it with administrator privileges. Run through the install process, ensuring you check the box to keep all your files and apps. When done, you're left with your new, fresh Windows folder and a separate "Windows.old" folder on your main drive, the latter of which contains your previous install. It's possible to roll back, if everything has fallen apart, but don't take this as an excuse not to have a proper backup. When happy (you have 10 days to decide), you can dump the "Windows.old" folder and reclaim that space.

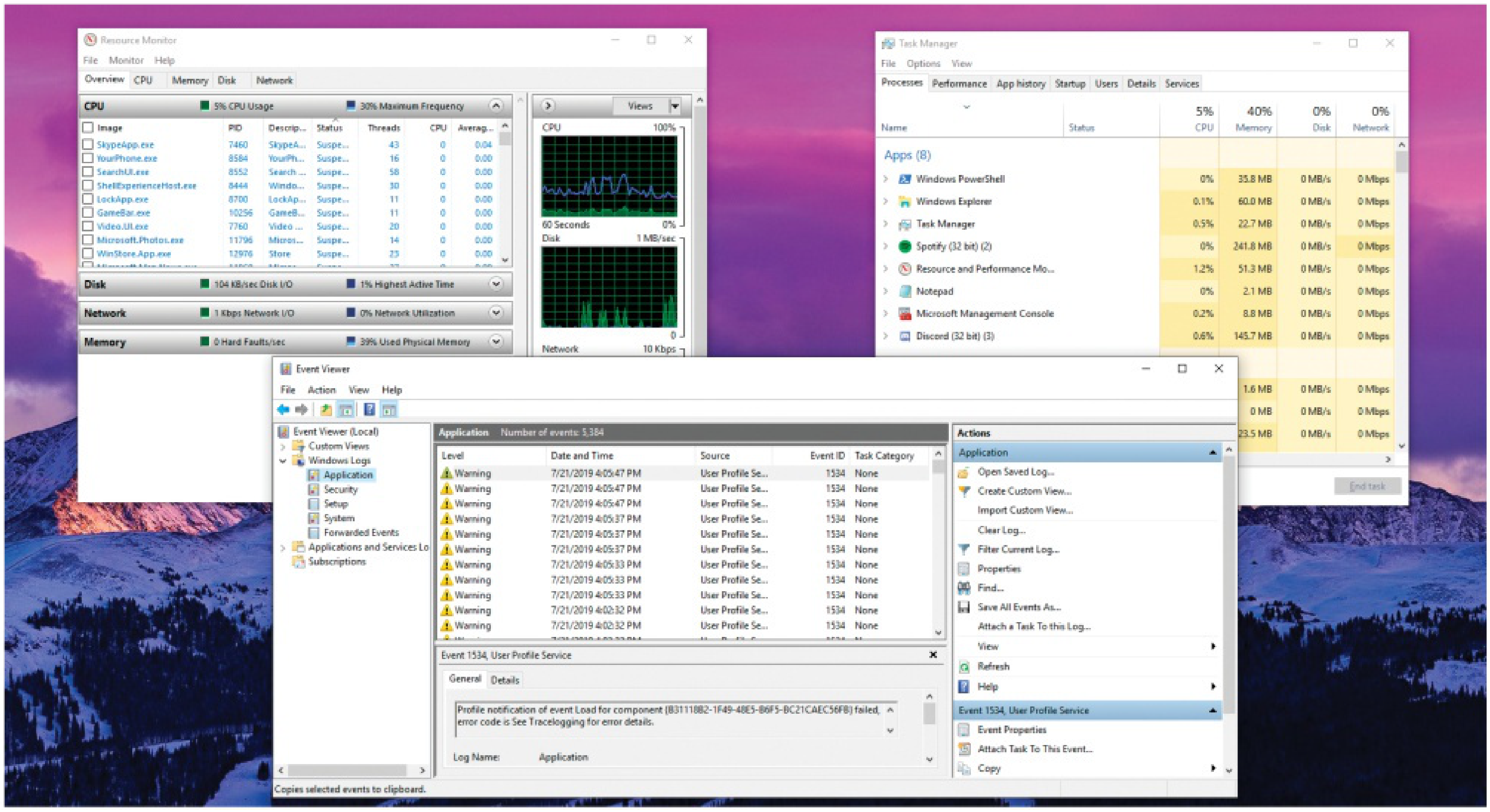
3

THE POWER OF ELBOW GREASE

MANY PEOPLE LOOK AT A WINDOWS reinstallation as a lazy way to fix any and all ills. However, we consider it as being more of a last resort. It's a little like dealing with unruly children. Before taking drastic action and shipping your PC off to military school, you should really do everything you possibly can to fix the problems you've got, and find out the cause of its misbehavior, because you might just find that a simple solution works better. Heavy-handed metaphor aside, keeping a keen eye on your PC's actions isn't particularly difficult, because Windows 10 includes all the tools you might need at your disposal: There's the Task Manager (which you can pull up at any time with a quick Ctrl-Shift-Escape); there's Resource Monitor (type "resmon" into the search bar) for a more detailed report on what's doing what; and there's even the difficult-to-grok but absolutely useful Event Viewer, which can throw up some worrying but utterly benign messages, but also reveal the true cause of system crashes or slowdowns.

CLEAN LIVING

It is worth keeping your system clean, not in terms of hard drive space (unless you're critically full, in which case, you should definitely start scrubbing), but in terms of the number of things that are installed on your system, how up to date they are, and how many of them you allow to just run whenever they like and eat up your system resources in the process. In terms of the latter, the Task Manager startup tab can give you some clues, not just about those auto-running apps, but also about the impact they tend to have on your startup process, and you can also use it to disable their automatic execution. If you want to get more involved with what happens at startup, Autoruns (https://download.sysinternals.com/files/Autoruns.zip) gives you much more granular and deep control, although you should



Resource Monitor
File Monitor Help
Overview CPU Memory Disk Network
Views

CPU 5% CPU Usage 30% Maximum Frequency

Image	PID	Descrip...	Status	Threads	CPU	Averag...
☐ SkypeApp.exe	7460	SkypeA...	Suspe...	43	0	0.04
☐ YourPhone.exe	8584	YourPh...	Suspe...	16	0	0.00
☐ SearchUI.exe	8552	Search ...	Suspe...	58	0	0.00
☐ ShellExperienceHost.exe	8444	Windo...	Suspe...	30	0	0.00
☐ LockApp.exe	8700	LockAp...	Suspe...	11	0	0.00
☐ GameBar.exe	10256	GameB...	Suspe...	11	0	0.00
☐ Video.UI.exe	7760	Video ...	Suspe...	20	0	0.00
☐ Microsoft.Photos.exe	11796	Micros...	Suspe...	14	0	0.00
☐ WinStore.App.exe	12976	Store	Suspe...	23	0	0.00

Disk 104 KB/sec Disk I/O 1% Highest Active Time

Network 1 Kbps Network I/O 0% Network Utilization

Memory 0 Hard Faults/sec 39% Used Physical Memory

CPU
100%
60 Seconds
0%
Disk
1 MB/sec
0
Network
10 Kbps

Task Manager
File Options View
Processes Performance App history Startup Users Details Services

Name	Status	5% CPU	40% Memory	0% Disk	0% Network
Apps (8)					
Windows PowerShell		0%	35.8 MB	0 MB/s	0 Mbps
Windows Explorer		0.1%	60.0 MB	0 MB/s	0 Mbps
Task Manager		0.5%	22.7 MB	0 MB/s	0 Mbps
Spotify (32 bit) (2)		0%	241.8 MB	0 MB/s	0 Mbps
Resource and Performance Mo...		1.2%	51.3 MB	0 MB/s	0 Mbps
Notepad		0%	2.1 MB	0 MB/s	0 Mbps
Microsoft Management Console		0.2%	8.8 MB	0 MB/s	0 Mbps
Discord (32 bit) (3)		0.6%	145.7 MB	0 MB/s	0 Mbps

End task
Event Viewer
File Action View Help
Event Viewer (Local)
Custom Views
Windows Logs
Application
Security
Setup
System
Forwarded Events
Applications and Services Lo
Subscriptions

Application Number of events: 5,384

Level	Date and Time	Source	Event ID	Task Category
Warning	7/21/2019 4:05:47 PM	User Profile Se...	1534	None
Warning	7/21/2019 4:05:47 PM	User Profile Se...	1534	None
Warning	7/21/2019 4:05:47 PM	User Profile Se...	1534	None
Warning	7/21/2019 4:05:37 PM	User Profile Se...	1534	None
Warning	7/21/2019 4:05:37 PM	User Profile Se...	1534	None
Warning	7/21/2019 4:05:37 PM	User Profile Se...	1534	None
Warning	7/21/2019 4:05:33 PM	User Profile Se...	1534	None
Warning	7/21/2019 4:05:33 PM	User Profile Se...	1534	None
Warning	7/21/2019 4:05:33 PM	User Profile Se...	1534	None
Warning	7/21/2019 4:02:32 PM	User Profile Se...	1534	None
Warning	7/21/2019 4:02:32 PM	User Profile Se...	1534	None

Event 1534, User Profile Service

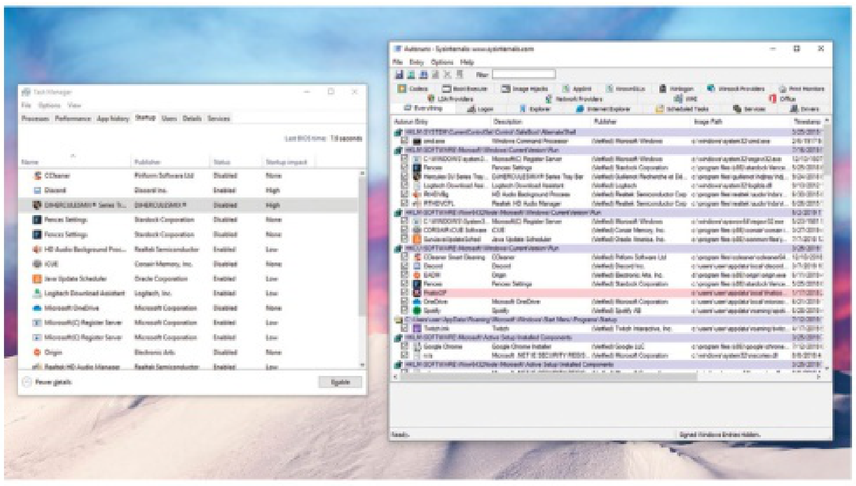
General Details

Profile notification of event Load for component {B31118B2-1F49-48E5-B6F5-BC21CAEC56FB} failed, error code is See Tracelogging for error details.

Log Name: Application

Actions
Application
Open Saved Log...
Create Custom View...
Import Custom View...
Clear Log...
Filter Current Log...
Properties
Find...
Save All Events As...
Attach a Task To this Log...
View
Refresh
Help
Event 1534, User Profile Service
Event Properties
Attach Task To This Event...
Copy
Copies selected events to clipboard.

The holy trinity of system spying: Task Manager, Resource Monitor, and Event Log.



Task Manager can help squash auto-running programs, but Autoruns can do a whole lot more.

treat it with kid gloves, because heavy-handed tinkering could potentially cause more problems than it solves.

So, what's the best way to deal with old, unwanted apps? To completely expunge them from your system, of course. There's nothing wrong with Windows' built-in uninstallation procedures. You can flit through your Start menu, right-clicking things that shouldn't be there, and using the "Uninstall" option to get rid of them. Or you could use the Apps & Features tool, accessible from Windows' settings panel, which (sometimes) offers up a bit more detailed information about when a program was installed, and when you last deemed it important enough to run it.

That usually works just fine. But if you'd like some more reassurance that a troublesome app is really gone, and with it any trace of its existence (we're well aware that revenge is usually a big contributor to any uninstallation process),

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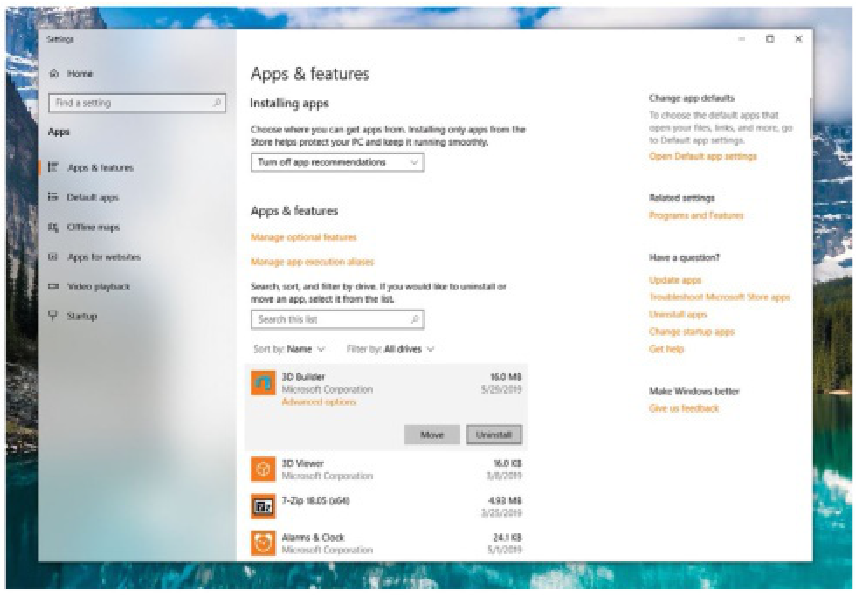


Choose where you can get apps from. Installing only apps from the Store helps protect your PC and keep it running smoothly.

Turn off app recommendations

Search, sort, and filter by drive. If you would like to uninstall or move an app, select it from the list.

Sort by: Name Filter by: All drives

3D Builder, Microsoft Corporation, Advanced options, 16.0 MB, 5/29/2019

3D Viewer, Microsoft Corporation, 16.0 KB, 3/8/2019

7-Zip 18.05 (x64), 4.93 MB, 3/25/2019

Alarms & Clock, Microsoft Corporation, 24.1 KB, 5/1/2019

To choose the default apps that open your files, links, and more, go to Default app settings.

Need to uninstall troublesome software? Windows' own tools are probably good enough for the task.

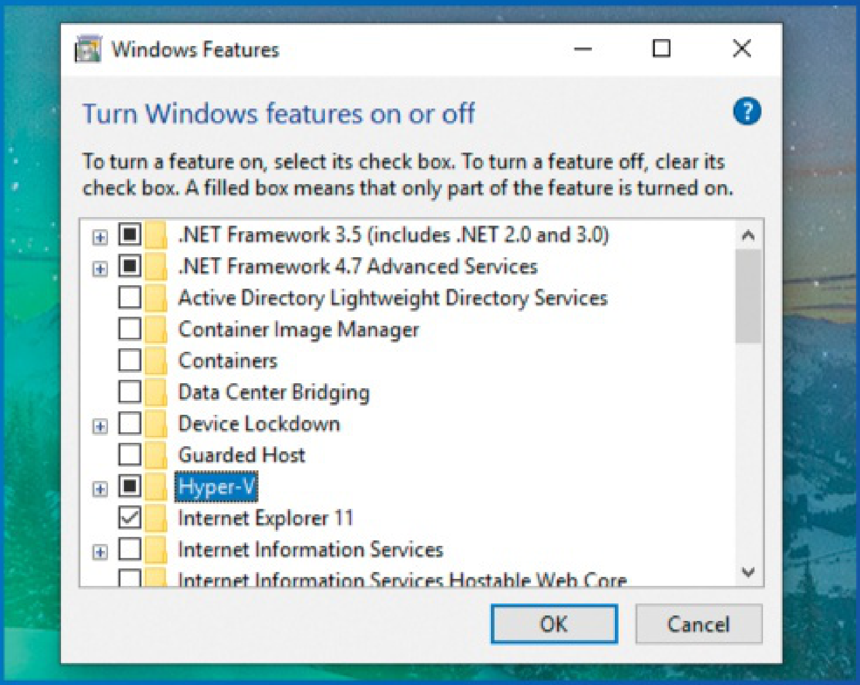
something like the free version of IoBit Uninstaller 8 (www.iobit.com) can work wonders. It makes software removal quick and straightforward, and it hunts for absolutely every file associated with the app that's on death row. We wouldn't opt for the paid-for Pro version, even though it adds extra tools for stripping away manufacturer bloatware, because apps such as PC Decrapifier (www.pcdecrapifier.com) do the job just fine without any outlay. It might be tempting to try out CCleaner (www.ccleaner.com), too, given that it can even get rid of Microsoft's default apps, and we're not going to stop you—but it's worth pointing out that CCleaner can be very annoying in terms of notifications. If we do use it, it's generally immediately removed once the task is complete. ⏻

GO VIRTUAL INSTEAD

We're at the point in the PC's evolution where the overheads of virtualization are proportionately so small, and the technology enabling it so plentiful, that running an everyday OS in a virtual machine is entirely reasonable. You obviously won't get 100 percent of bare metal performance from a virtualized instance of Windows 10, but it has a host of advantages. When you've got a system running just as you like it, you can take a snapshot, then quickly return to it at any point in the future. You can whip up a fresh copy of Windows in minutes, without any risk to your existing install. You can fire up other operating systems, and run them simultaneously on the same machine. If you're the kind of person who loves to settle down to a good Windows reinstall in the evening, then you're probably the right candidate for running a virtualized system.

We could fill an entire issue of *Maximum PC* with ways to do it, but if you're willing to experiment, here's a broad framework that's a good place to start. Use Fedora Workstation as your host OS (https://getfedora.org/en/workstation) and use the included Boxes app (a front end for KVM/QEMU) to get your VMs up and running. Install VirtIO to ensure that all of the IO functions work properly, and SPICE to deal with 3D acceleration. And make sure you've accessed your BIOS/UEFI settings and enabled all the good stuff that makes VMs work well—specifically Intel-VT or AMD-V, depending on your platform.

If you fancy a challenge, both VMWare ESXi and Microsoft Hyper-V Server are pro-grade bare-metal hypervisors, which put a minimal layer between your host OS and the hardware they're working with, but they do require some pro-grade understanding to get the most out of them, so are beyond the scope of this feature.

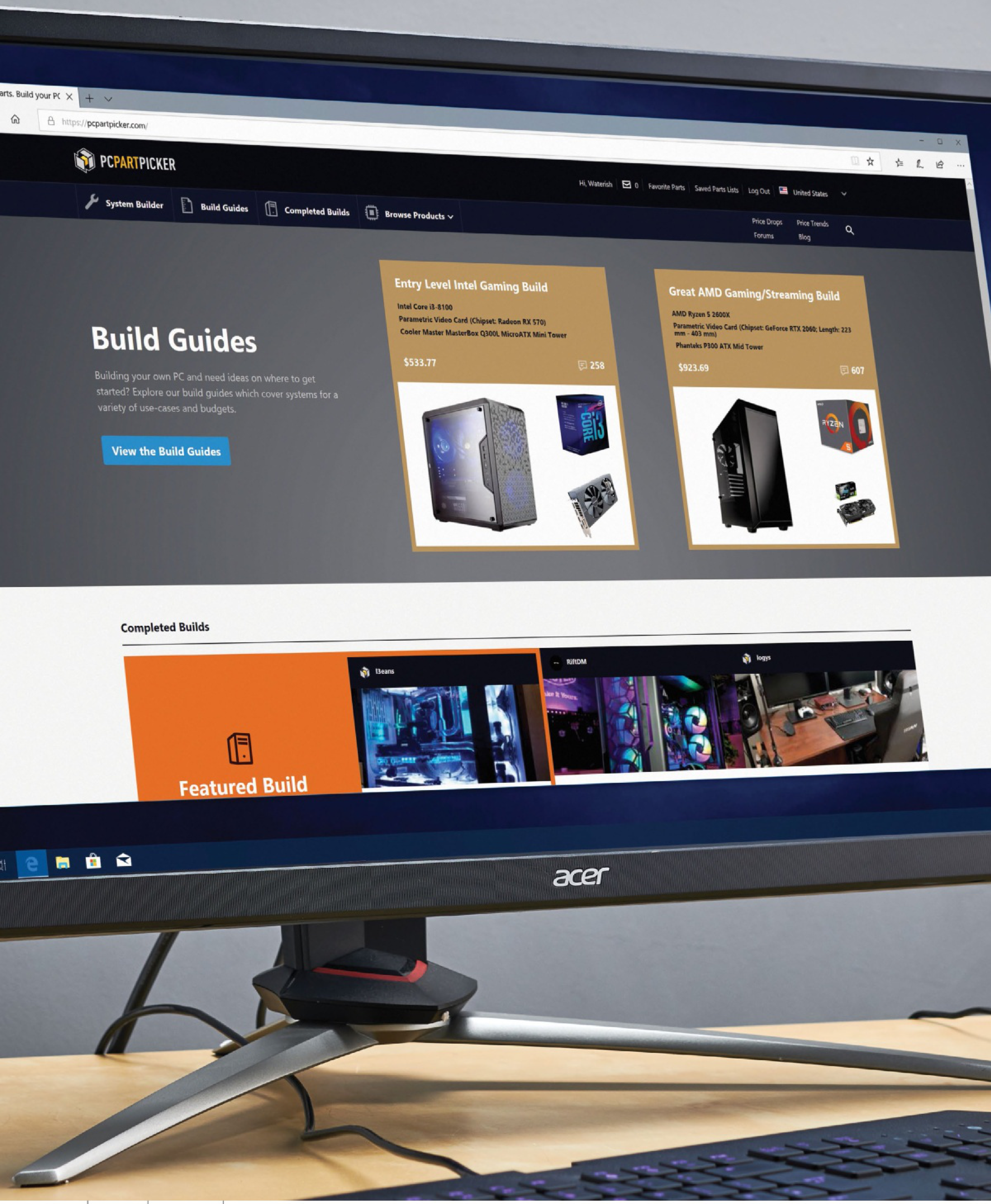


Turn Windows features on or off

To turn a feature on, select its check box. To turn a feature off, clear its check box. A filled box means that only part of the feature is turned on.

- ■ .NET Framework 3.5 (includes .NET 2.0 and 3.0)
- ■ .NET Framework 4.7 Advanced Services
- ☐ Active Directory Lightweight Directory Services
- ☐ Container Image Manager
- ☐ Containers
- ☐ Data Center Bridging
- ☐ Device Lockdown
- ☐ Guarded Host
- ■ Hyper-V
- ☑ Internet Explorer 11
- ☐ Internet Information Services
- ☐ Internet Information Services Hostable Web Core

If you have Windows 10 Pro installed on your machine, you have access to some form of Hyper-V already.


arts, Build your PC
https://pcpartpicker.com/
PCPARTPICKER
Hi, Waterish
0
Favorite Parts
Saved Parts Lists
Log Out
United States
System Builder
Build Guides
Completed Builds
Browse Products
Price Drops
Price Trends
Forums
Blog
View the Build Guides
Completed Builds
Featured Build
13eans
RiftDM
logys
acer

Build Guides

Building your own PC and need ideas on where to get started? Explore our build guides which cover systems for a variety of use-cases and budgets.

Entry Level Intel Gaming Build

Intel Core i3-8100
Parametric Video Card (Chipset: Radeon RX 570)
Cooler Master MasterBox Q300L MicroATX Mini Tower

$533.77
258

Great AMD Gaming/Streaming Build

AMD Ryzen 5 2600X
Parametric Video Card (Chipset: GeForce RTX 2060; Length: 223 mm - 403 mm)
Phanteks P300 ATX Mid Tower

$923.69
607

THE BEST PC-BUILDING ASSISTANTS

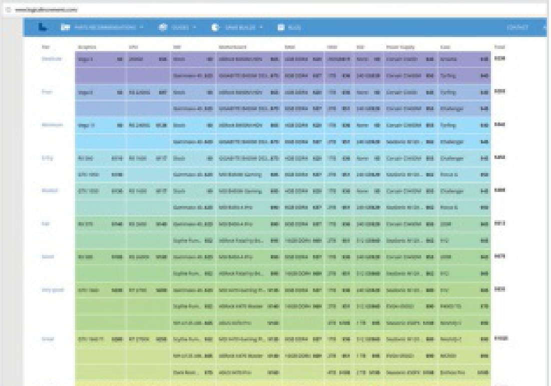
Need help with your PC build? These are our go-to resources for everything PC related. *By Alex Blake*

IF YOU'RE A REGULAR reader of *Maximum PC*, you'll know we have a soft spot for PC Part Picker (http://pcpartpicker.com). It's a fantastic website that takes the hard work out of putting together prospective PC builds. Not only does it alert you to any incompatibilities, but it shows you the best prices for each component you want to use, plus stats, measurements, and ratings for everything. There are handy build guides for every budget, and community showcases so you can view and rate your fellow enthusiasts' work. It's required reading for anyone looking to build a PC today.

But that doesn't mean it's the only resource at your disposal when it comes to putting together your next build. There are plenty of other places you can go, whether you're in the initial planning stages or looking to fix an issue post-build. With so much help available on the Internet, now is a fantastic time to build a PC, knowing the help you need is just a few clicks away.

It may sound obvious, but one place we can't recommend enough is YouTube. It's stacked full of PC-building guides, with plenty of experts offering their own tips. It's particularly useful if you're staring at a poorly translated or hopelessly vague manual and wondering how your components are meant to fit together. After all, it's fine being told how something should be installed, but seeing someone else do it can be so much more helpful. When you're spending your hard-earned cash on a new computer, you need to make sure it's put together properly, and checking YouTube is a great way to ensure that happens.

In addition to that, we've rounded up five of our favorite resources when it comes to building a PC. Each one has its own strengths, so you should find something to suit your needs whatever you're after, and each is dedicated to taking the pain out of PC building. Give them all a read to pick up some invaluable tech tips.



LOGICAL INCREMENTS

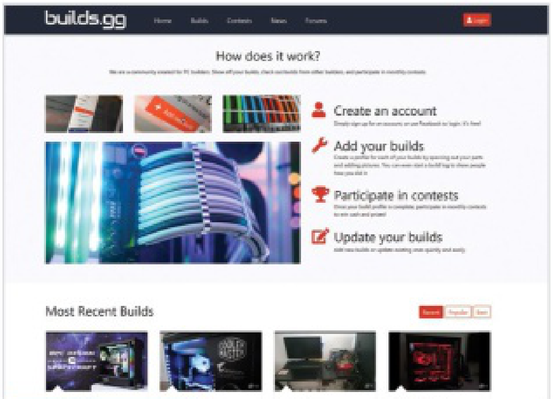
www.logicalincrements.com

Sorted by increasing budget brackets from "Destitute" to "Monstrous," Logical Increments puts together complete builds for you with recommended parts for each price range. While PC Part Picker somewhat shies away from outright recommendations, and leaves tips up to its users, Logical Increments shows you which parts represent the best quality and bang for your buck, and which parts they're best matched with. It's a quick way to find the ideal build for your budget.

Not only that, but it has guides for standalone components such as monitors, mice, and keyboards, as well as graphics cards rankings and recommended CPU coolers from each of the major brands.

There are also guides organized along use cases: "Building a PC for VR Gaming," for example, or "Building a PC for Video Editing." These give example builds and go into depth on what you need to look out for when picking components for your needs. It's an impressively in-depth resource if you have a goal in mind.

And if you're into gaming, you're in luck here, too. Logical Increments has put together build guides and parts lists for each of a series of popular games. Each one considers budget and monitor resolution, ranking builds from "Unplayable" to "Buttery Smooth."



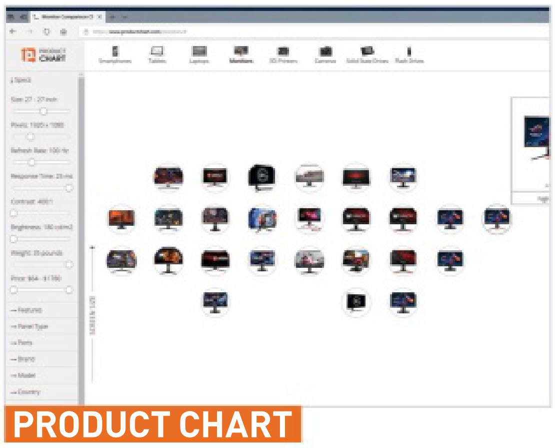
BUILDS.GG

www.builds.gg

Builds.gg is similar to PC Part Picker, but with more of an emphasis on the community. So, if you want to get inspiration and see what fellow PC builders are up to, you should head to Builds.gg and join in. Like PCPP, you can create your own build and view others here, but there are also monthly contests and a section on popular builders, where you can follow their work. And while PC Part Picker is great for newcomers who want to make sure that everything in their build is compatible, Builds.gg is aimed more at enthusiasts who love the PC community and want to get involved in it.

You'll notice that immediately when you first visit the Builds.gg homepage. User builds are featured prominently, enabling you to dive straight in to see what other people have been working on. This is not only a great way to see how your build might look in its finished form, but the comments provide lots of useful feedback and tips to builders, and are an excellent place to pick up ideas.

We also really like the "Popular Builders" section, which highlights users who have been recognized by the community. You'll find some familiar names in here, such as JayzTwoCents and Linus Tech Tips, and plenty of inspiring builds.



PRODUCT CHART

www.productchart.com

Lord knows comparing two PC components can be a frustrating affair. Even the simplest of comparisons can require flicking back and forth between spec sheets, which are often inadequately detailed or missing altogether. It's enough to make you want to tear your hair out.

Product Chart is a great answer to that problem. It's a brilliant visual way to choose a new component, with sections for monitors and solid-state drives, plus other categories such as laptops and tablets. Choose a component, and you're greeted with a chart with products plotted across it. On the monitor page, for instance, "Price" is plotted along the bottom, while "Screen size" is running up the vertical axis.

You specify your needs and the chart narrows down your options, quickly giving you a way to compare the products on offer. It also shows you what the products look like (you don't want to spend all day staring at an ugly monitor, after all), lists their prices, and lets you highlight or dismiss particular products. It's perfect if you find yourself having information overload when trying to pick components.

Comparing components can seem daunting, but Product Chart makes it easy, thanks to its visual approach.

©LOGICALINCREMENTS.©BUILDS.GG ©PRODUCTCHART

PC BUILDING SIMULATOR

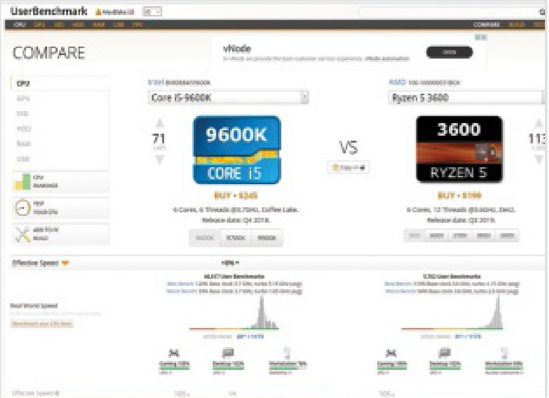
What if you could put together a PC component list, practice building it, and see it in action, without ever having to leave your desk? That's what you get with *PC Building Simulator.*

This game enables you to put everything together and see how it all looks, letting you decide whether the final product is something you would be happy with. The game contains fully licensed real-world components from over 30 different brands, including Nvidia, AMD, Corsair, Gigabyte, and MSI, so you know you're getting accurate representations of the components you're thinking of buying.

Not only that, but it's a helpful way to learn how to fit the components together into place without risking breaking anything. If something doesn't fit or could be tricky to mount correctly, you'll quickly find out by trying it first in *PC Building Simulator.*

One element of the game we really like is its integrated benchmarking system. Once you've virtually put everything together, you can benchmark your new rig using 3DMark to see how it performs, then jump into the BIOS and overclock it if necessary. That's a great way to avoid buyer's remorse when you find out your build is less performant that you'd hoped.

You may think this is all well and good, but it's not much of a game. Well,



USERBENCHMARK

www.userbenchmark.com

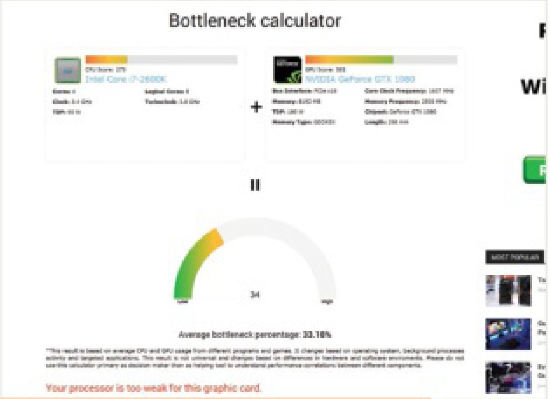
One tried and tested way of checking a computer product's quality is through benchmarking. And what's better than running one or two benchmarks? Sourcing millions of benchmarks from PC users all around the world, of course.

That's what you get with UserBenchmark. It enables users to test their components, utilizing this information to build up a massive database of almost 92 million benchmarks for almost every component on the market. You can select a product and see how it scores across a wide range of benchmarks, plus how suitable it is for gaming, desktop, and workstation builds.

What's more, UserBenchmark becomes even more valuable when you compare two products. It breaks down the comparison into a ton of useful categories, both basic and advanced, all using that same user-submitted benchmark data. It's ideal if you need a quick way to tell which product is better and don't have time to read lengthy reviews.

Like Builds.gg and PC Part Picker, there's a PC builder section that creates a score for your build as you put it together. You can see prices for each of the components, helping you meet your goal for quality, and stay under budget.

©USERBENCHMARK © PC-BUILDS


Bottleneck calculator
Intel Core i7-2600K
NVIDIA GeForce GTX 1080
34
Average bottleneck percentage: 33.18%
Your processor is too weak for this graphic card.

PC BUILDS' BOTTLENECK CALCULATOR

http://pc-builds.com/calculator

When it comes to PC building, a bottleneck is when either your processor or graphics card is too slow for the other component. If your CPU is bottlenecking your graphics card, for example, your GPU can't reach its potential, because the CPU will be holding it back.

To find out if your build has a bottleneck, use PC Builds' bottleneck calculator. Just pick your processor and graphics card, click "Calculate," and the website shows you where the problem lies.

That's all very useful, but PC Builds goes further. Once you know the weak link, the website suggests an alternative that you can upgrade to. This isn't necessarily the latest and most powerful component—it's carefully picked to be at an appropriate level for your other components. Alternatively, if you wanted to downgrade the more powerful component to save money, there are suggestions for that, too.

PC Builds also has a database of games to check your components against. Click "Can You Run It" and pick a game to see what FPS you're likely to get at various quality settings and resolutions—perfect for checking whether your build is going to meet your targets.

ASK THE COMMUNITY

Sometimes, it's best to ask your fellow PC enthusiasts for help. With 1.6 million members, Reddit's Build a PC subreddit is one of the largest collections of PC-building enthusiasts on the Internet. It's one of the best places to go for buying advice, tips, and tricks from other PC builders.

The community is known for its friendly, welcoming approach, whether you're a newcomer, a seasoned pro looking to take your build to the next level, or someone who needs help troubleshooting.

At the top of the page is a menu bar with links to the community's PC-building wiki and its Discord server. Be sure to also check out the "Resources" link—as well as links to old favorites such as PC Part Picker, you'll find user-written guides on everything from picking an operating system to putting the finishing touches on your build. There's also a helpful video guide to building a PC.

Reddit has a number of other excellent PC-related communities. We particularly like Build a PC Sales (www.reddit.com/r/buildapcsales), which highlights price cuts on PC hardware, and GameDeals (www.reddit.com/r/gamedeals), which does the same for games. Reddit's PC hardware group (ww.reddit.com/r/hardware) is a great place to visit if you want to discuss PC components.

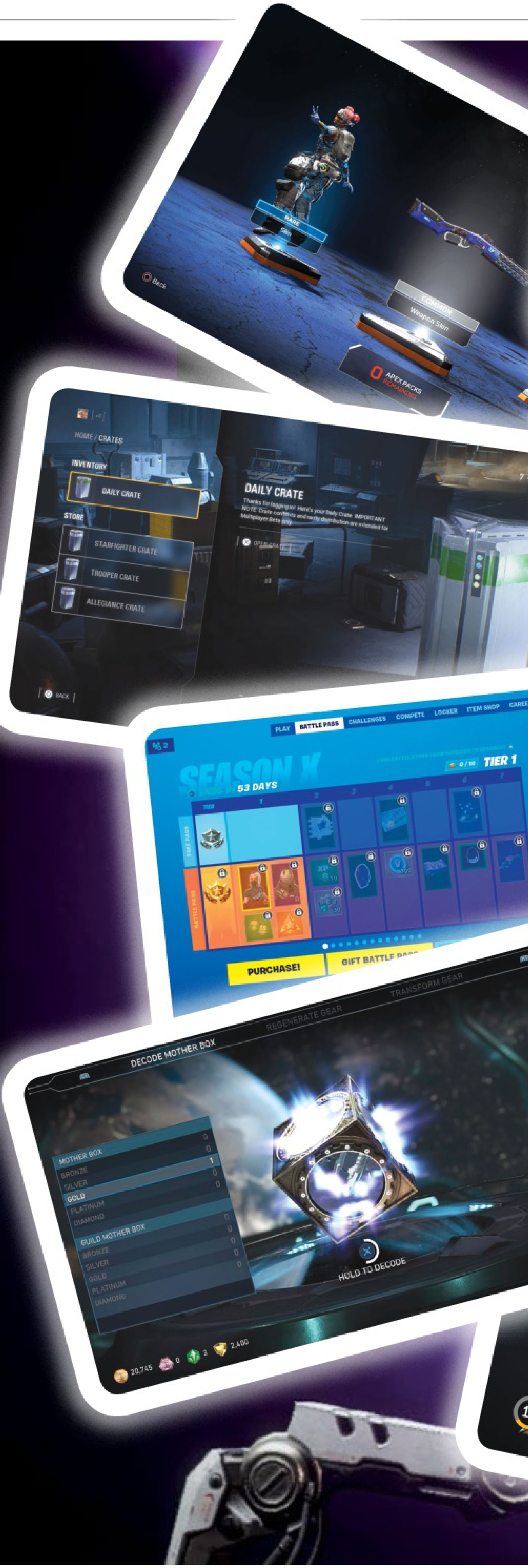
There are plenty of other good places to go for support. The forums at Tom's Hardware, Linus Tech Tips, and HardForum are all well-known places to go to discuss all things PC-related. Try your luck there; you're sure to find the answers you need.

PC Building Simulator **lets you put yourself in charge of a virtual PC-building company, taking orders from customers with everything from simple upgrades to complete system builds, all while trying to remain profitable.**

The game was created by a member of Reddit's Build a PC community (see "Ask the Community," on the right) and went viral, with over 650,000 downloads of its pre-alpha demo. If it sounds like something you'd want to try, it's available on Steam and GOG.

PC Building Simulator **lets you try your hand at building a PC in a virtual environment.**

THE DEATH OF THE LOOT BOX


RARE
Skin
COMMON
Weapon Skin
0 APEX PACKS REMAINING
Back
HOME / CRATES
INVENTORY
DAILY CRATE
STORE
STARFIGHTER CRATE
TROOPER CRATE
ALLEGIANCE CRATE
DAILY CRATE
BACK
PLAY
BATTLE PASS
CHALLENGES
COMPETE
LOCKER
ITEM SHOP
SEASON X
53 DAYS
TIER 1
FREE PASS
BATTLE PASS
PURCHASE!
GIFT BATTLE PASS
DECODE MOTHER BOX
REGENERATE GEAR
TRANSFORM GEAR
MOTHER BOX
BRONZE
SILVER
GOLD
PLATINUM
DIAMOND
GUILD MOTHER BOX
BRONZE
SILVER
GOLD
PLATINUM
DIAMOND
HOLD TO DECODE
20,745
2,400

Could the reign of random-rewards terror finally be coming to an end?

AH, THE LOOT BOX. Truly, the antithesis of genuine fun or any sense of real progression in games. Call them what you like—loot crates, booster packs, lock boxes, whatever—the principle is the same: Crack it open and receive in-game loot of varying rarity, typically falling at the common end of the scale. Most games let you steadily earn loot boxes through normal gameplay, but there's always that option—come to the market, buy a whole bunch, and open them all at once! You know you want to.

Loot boxes tap into what psychologists call a "compulsion loop," a repeated activity that triggers the release of dopamine in the brain, granting mental satisfaction upon acquiring virtual rewards. Many games, by their very nature, utilize compulsion loops. If you've played any MMORPG, you'll be familiar with the system: Killing monsters and completing quests grants you superior gear, which enables you to kill stronger monsters and complete harder quests. Loot boxes cut out all that annoying "gameplay" nonsense, letting you buy rewards. You still earned them, the publishers cry out. You worked hard for that money in the real world. We hope you feel a sense of pride and accomplishment.

But are these pricey digital grab bags on the way out? Loot boxes do represent a huge revenue stream in the games industry, but all is not well. With arguments being made about the ties between loot boxes and gambling, some countries taking steps to ban or limit them, and goodwill from gamers rapidly in decline, it's not looking good for the loot box....

BY CHRISTIAN GUYTON

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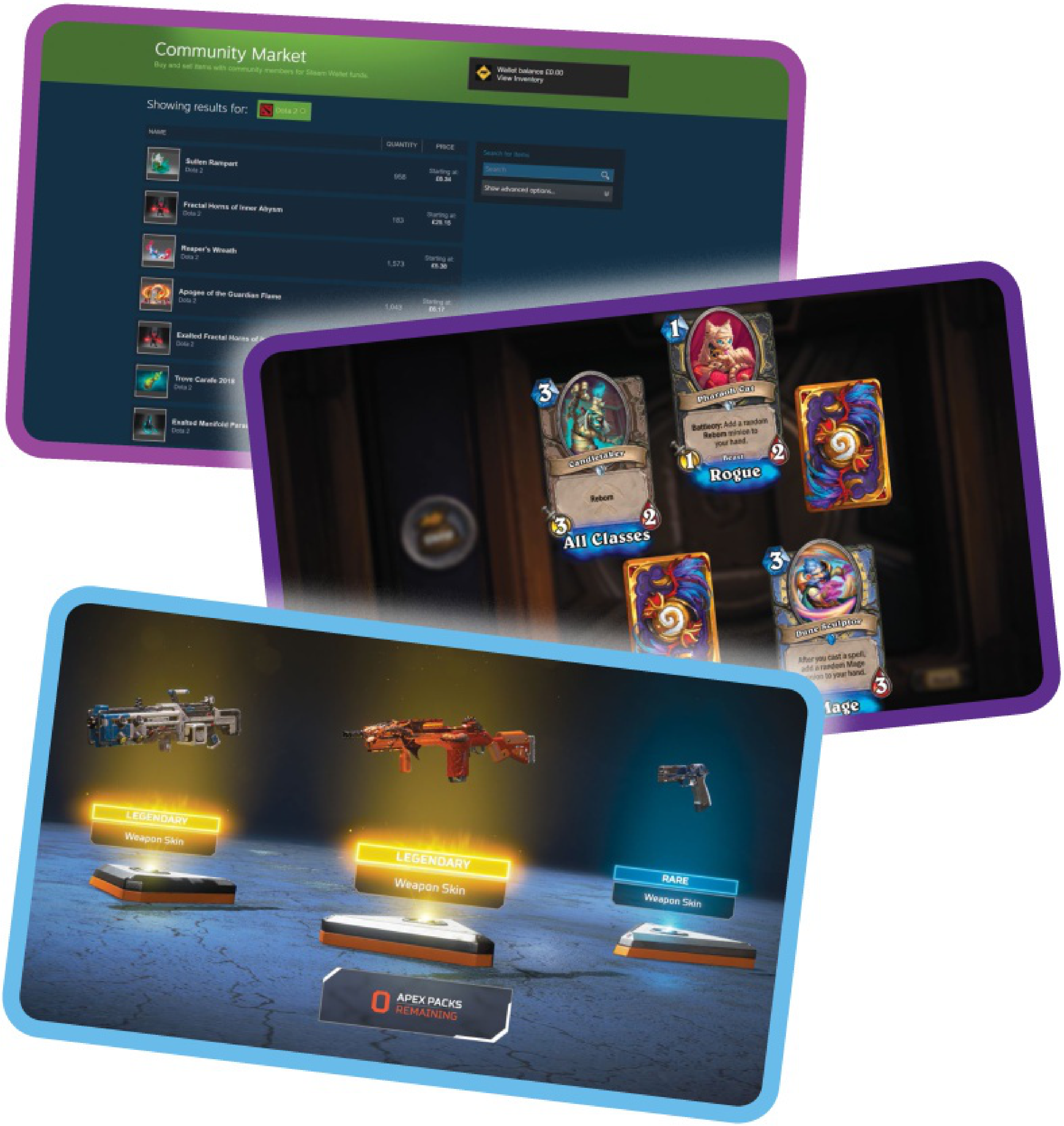
MARKET
Garrison
Featured: Assassin's War Chest
Purchase
Get More
Back
Bundles
War Chests
Loot Chests
Boosts
505
175
Assassin's War Chest
Cost
240

Recruit three Orc Assassins to eliminate your enemies.

- 3 Orc Assassins: At Least 1 Legendary, 2 Epic
- 2 Consumables: From any of our Training Orders and Two-Hour Spoils of War Boosts

NEW! 23 DAYS
LUCKY DRIVER GEAR CRATE
NEW! 23 DAYS
LARGE MYSTERY CRATE
MODS CRATE – PREMIER
MIXED CRATE – BASIC
MIXED ADVANCED – CRATE
MIXED CRATE – ELITE
STORE
300
2 of 12
LEGENDARY | OUTFIT
CATALYST
Replay Cinematic
15
Ronk Beast Butcher
Cursed Feral Destroyer (EPIC)
[X] Details
GEAR
300
400
400
500
PREMIUM PACK
Instantly get 5
2 Gear of higher
WARDEN
9/60 Gear Inventory
299
BACK



Above from top: **Valve's Steam Marketplace perpetuates a lot of the player-to-player trading of loot box rewards.**

Online fantasy card game *Hearthstone* ups the ante by having players reveal their loot box rewards.

A particularly lucky loot box opening here in *Apex Legends* awards two gold-rarity items.

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WHILE LOOT boxes have featured in games for some time, they've only recently been pushed into the limelight, due in part to the huge popularity of certain games. Blizzard's *Overwatch* was released in 2016, with loot boxes included at launch, and the huge financial success of the hero-based shooter spurred other developers to focus on the potential profits waiting inside those loot-filled containers. Within a year, the majority of triple-A multiplayer releases had followed suit and shoehorned loot boxes into their games, with the one notable outlier being the infamous *Fortnite: Battle Royale*.

The driving principle behind loot boxes is simple enough: As the games industry became more lucrative, driving investments in long-running franchises and broadening the audience for games, developers and publishers were encouraged to seek greater profits from their increasingly expensive projects. 2018 was the biggest year ever for the industry, with the global software market passing a staggering $137bn, 10 percent up from the previous year, and predicted to grow further.

Loot boxes represent a low-effort but high-return input for games. Previously, the sole profit from designing and producing a game came in the form of initial sales revenue; producing a sustainable income stream demanded the release of sequels or spin-offs. Then came the expansion pack, bringing additional content to beloved titles at a lower price than that of the base game. People began to make their own content; map packs, mods, and more became available to download as gaming entered the online age, and it didn't take long for developers to start capitalizing on that. Downloadable content (DLC) slowly became a staple of games, starting with titles such as Cavedog Entertainment's 1997 game *Total Annihilation*, which allowed players to download small new additions each month.

MICRO MANAGING

Total Annihilation's content was very small, and free to download. One of these two characteristics would survive as the predominant feature of much DLC. Can you guess which? If you guessed "free to download," we suggest you relocate your house out from underneath that rock. Yes, many developers have included small pieces of bonus content after release, but it's far from the norm—despite unilaterally positive responses from gamers. When CD Projekt Red's award-winning *The Witcher III: Wild Hunt* was released, fans were drip-fed numerous small add-ons with no price tag, leading up to a pair of high-quality paid expansions, and gamers rejoiced.

So, smaller is better. When the Xbox 360 was released in 2005, Microsoft reasoned that gamers were more likely to spend between one and five dollars on a small piece of content for a game they enjoyed than commit $25 to a larger expansion. This proved to be a successful strategy, with the Xbox Live Marketplace producing huge profits for Microsoft. Thus was born the microtransaction. Developers could sell bite-sized pieces of content for their games, which took less time and money to create, but reached a potentially wider audience than larger, more expensive DLC.

Not every microtransaction was met with acclaim, of course. Bethesda drew serious ire for its two-dollar horse armor package for *The Elder Scrolls IV: Oblivion*, which was derided to such an extent that it remains an industry joke years later. But some games fitted right in: Rhythm-action games like *Guitar Hero II* boasted huge amounts of DLC at tiny prices, specifically individual songs from licensed musicians to play in game.

Sadly, the money involved resulted in corporate greed taking over. Day-one DLC became a much-hated feature in many games, where gamers perceived (often correctly, let's be honest) that parts of the finished game were being held back behind a paywall to try to squeeze an extra few dollars

THE ORIGINS OF THE LOOT BOX

Real-world loot boxes have been around for far longer than their digital counterparts. Taking aside actual gambling (a slot machine is arguably a sort of loot box, but we're not going to get bogged down in semantics here), there are examples that might not immediately seem akin to loot boxes, but effectively serve the same purpose. Any trading card game aficionados reading this will no doubt know about booster packs, containing half a dozen or so random cards with one guaranteed "rare"—a mechanic that carries over to many in-game loot boxes. These made the leap successfully to the digital format, with many online card games featuring virtual booster packs.

Another key aspect of the loot box's conception was *gashapon* toys. Originating in Japan and also called *gachapon* or simply *gacha,* these are tiny toys and figurines that can be purchased from vending machines, which deposit a sealed capsule containing a random gift from a predetermined collection. A similar product is a common sight in physical game retailers across the world: blind-box figurines, which are effectively the same thing, minus the capsule and vending machine.

Funnily enough, *gacha* toys would become the basis for the very first in-game loot box ever to be implemented. In 2004, the massively popular free-to-play MMORPG *MapleStory* introduced Gachapon Tickets, a premium currency purchasable via microtransactions that could be spent on rolls at a virtual *gachapon* machine to acquire random items. These were only available in the Japanese version of the game, but *MapleStory* developer Wizet enjoyed a modicum of profit from the new feature. It would be a long time before the global popularization of loot boxes, though.

Commonplace in Japan, you might also have seen these vending machines around in the West.

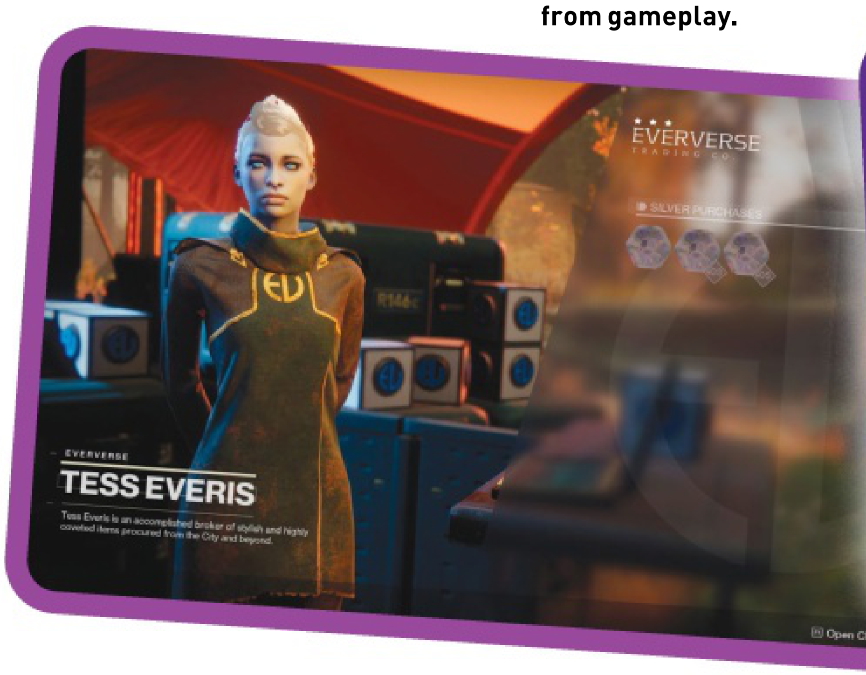
from players immediately after release. One of the worst offenders was EA's *Mass Effect 3,* which not only offered a pretty crucial story expansion for purchase on day one, but is also credited—albeit in a dubious sense of the word—with being the first full-price release to feature loot boxes at launch. Much like the loot boxes popularized by games such as *Overwatch* and *League of Legends,* these "supply packs" could be earned by grinding away in *Mass Effect 3's* multiplayer mode, or purchased in bulk with real-world money.

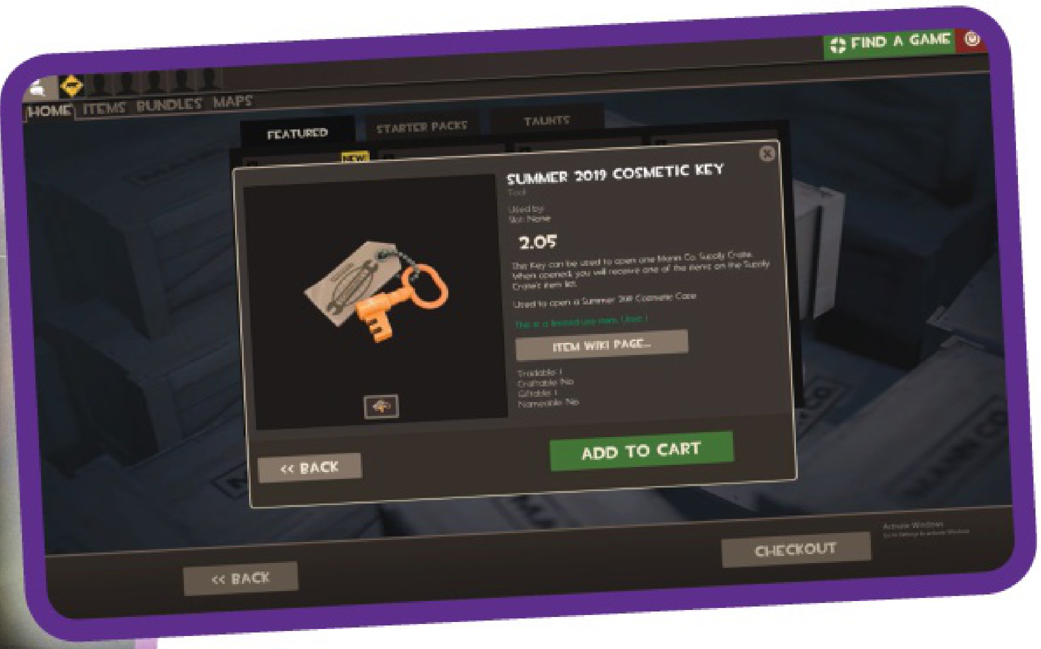
CHOOSE LOOT

Herein lies a key component of the archetypal loot box's design: You don't have to pay for them. Almost without exception, it is possible to earn loot boxes and their pseudo-random rewards simply through sustained gameplay. That's the catch—developers can claim that no content is locked off to players who won't shell out their hard-earned cash; it's merely time-gated until they've put in the relevant amount of effort. *Overwatch* is a good example: Loot boxes are awarded upon leveling up and completing weekly milestones, providing a constant stream of cosmetic rewards for regular players. The game received some criticism for being a full-price game that heavily featured loot boxes, but modern free-to-play games are

Below-left: ***Destiny 2*** **has players going to a specific vendor to unlock their loot boxes.**

Below-right: **Some games, such as *Team Fortress 2,* sell keys for loot boxes earned from gameplay.**





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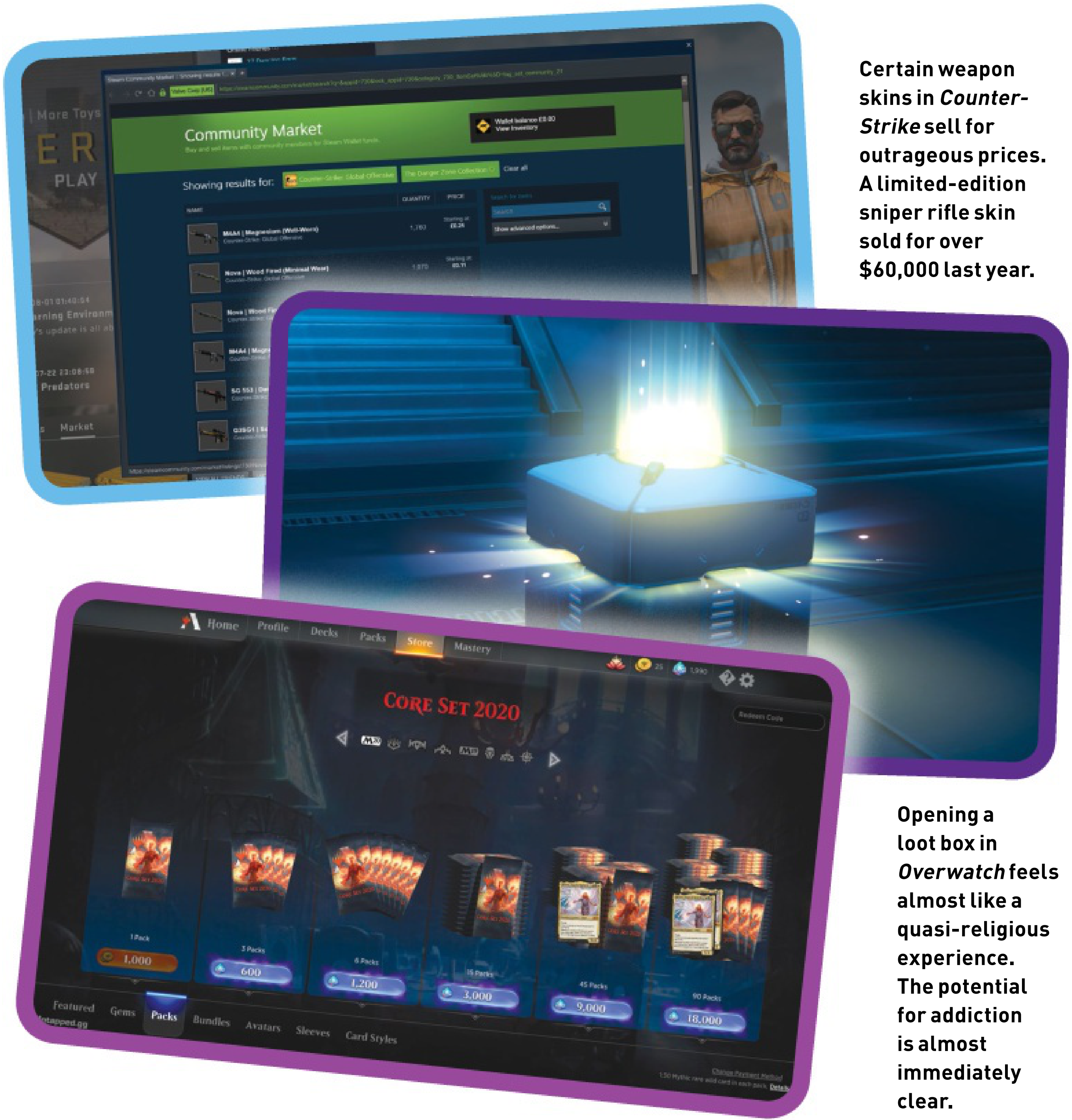

Certain weapon skins in *Counter-Strike* sell for outrageous prices. A limited-edition sniper rifle skin sold for over $60,000 last year.

Opening a loot box in *Overwatch* feels almost like a quasi-religious experience. The potential for addiction is almost immediately clear.

Booster pack bundles in card games, such as *Magic: The Gathering Arena*, can get incredibly expensive if you want to buy lots of cards.

rarely given a free pass by gamers either when it comes to loot boxes.

Many gamers might pour hours upon hours into a game, yet never spend a cent on it (beyond the initial price for paid titles). Then there are "every now and then" gamers, with a little disposable income, who are drawn in by a discount deal or an in-game event promising exclusive items. Next are regular purchasers, who effectively pay a subscription to keep receiving loot boxes on a continual basis. Lastly, there are whales, those with a vast disposable income (or Mom's credit card) who spend inordinate amounts of money for a never-ending stream of digital prizes.

To take advantage of these different tiers of gamers, games adapted to cater for different budgets. While a single loot box might cost a dollar or so, there's always an option to purchase 20, or 50, or more. With massive price tags justified by supposed discounts (buying more loot boxes at once incrementally reduces the individual price per box), people quickly began to become frustrated. This problem was compounded in games where loot box rewards had an actual impact on gameplay.

When the possible contents of loot boxes are purely cosmetic—such as skins, emotes, and other aesthetic items—any player can choose not to purchase them, and not be any worse off when it comes to playing the game than players who did. But some games—most notably trading card games that use booster packs, and sports games such as the ever-present *FIFA*—feature purchasable loot boxes that have a tangible effect on gameplay, potentially putting paying players at an advantage over those who don't buy loot boxes, and often leading to ire from the non-paying crowd.

So, ill will from gamers about loot boxes has been a cauldron close to boiling over for quite some time, but publishers still have the power to disregard the whims of their consumers. When you're flipping profits in the millions, what are the voices of a disheartened minority who aren't contributing to the aforementioned profits anyway? Never fear, though, gamers: Someone's coming to your rescue, and it's… politicians?

ADDICTION FRICTION

Yes, the latest to take aim at the loot box fiasco is a wide array of politicians, law-makers, and researchers. Oh, and don't forget the concerned parents, too. Their rationale for wanting loot boxes gone might not be the same as the humble gamer, though; while a gamer might merely be frustrated by the inability to get that weapon skin they so desperately want, the new bastion in the battle against the loot box is pushing a platform that claims loot boxes are a form of gambling—at worst, a predatory gambling practice aimed at children—and thus require tighter regulation. In fact, we're surprised no politician has used the phrase "the War on Loot Boxes" yet.

The thing is, they're not wrong. Even a cursory glance at the mechanics behind loot boxes reveals quite indisputably that the random nature of the attainable rewards holds a degree of gambling within it. When considering the fact that the rewards are a digital commodity that is infinitely reproducible by the company selling the loot boxes, things start to look even dicier for game developers. And while "real" gambling (such as the ability to play games of chance with in-game cash, as seen in the *Red Dead* series) often affects a game's recommended age rating, loot boxes do not, furthering the argument that they are targeted toward vulnerable younger users.

Examining the psychological effect of loot boxes only furthers this argument. The very act of opening a loot box in many games has a number of subtle (and not-so-subtle) design choices that feed into their addictive nature. Boxes often require you to hold down a button, rather than simply press once, driving the idea that this is more of an achievement. The boxes glow, shake, make odd noises, and even spin around in some cases, prior to blasting out their loot. Before

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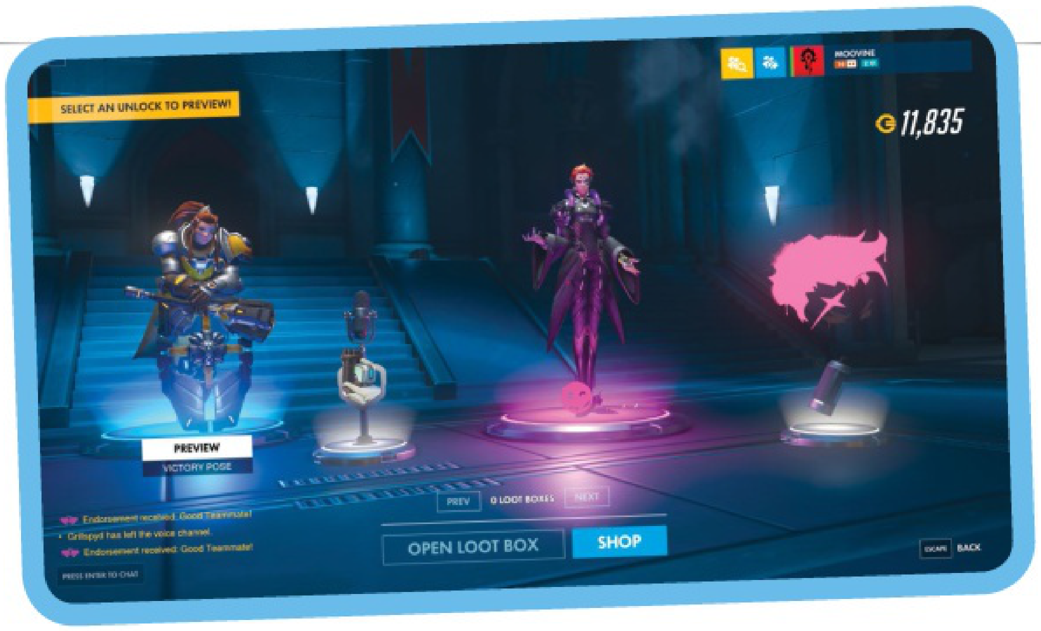


Endorsement received: Good Teammate!
Grilspyd has left the voice channel.
Endorsement received: Good Teammate!
PRESS ENTER TO CHAT

Reward rarity is a key element of loot boxes, typically utilizing color coding to make rare rewards instantly recognizable.

you even see your rewards, you're teased for a brief moment by lighting effects in the colors of the well-adopted loot rarity system in games: white-blue-purple-gold, with gold being the rarest. Seeing that glimmer of purple peek out as the player opens the box drives excitement, while a lack of rare colors leaves the player wanting to open another one before they've even seen their actual rewards.

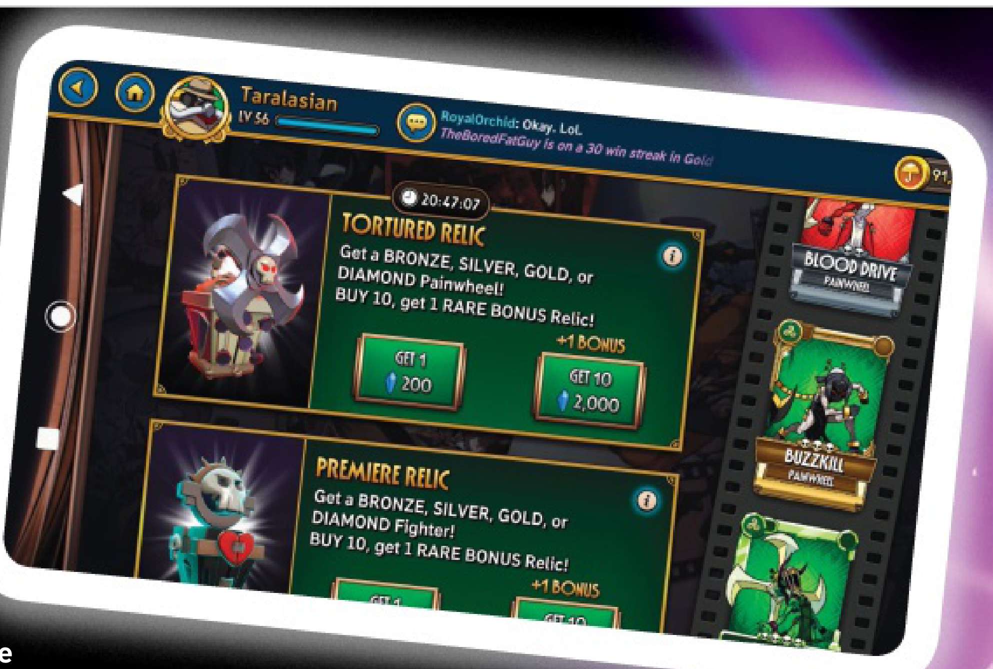
TAKING CHANCES

The War on Loot Boxes is already won in some parts of the world. China's Ministry of Culture issued a ruling that required developers to disclose the probabilities of getting various items from loot boxes, as well as new regulations limiting the number of loot boxes that could be purchased by a single player each day, and increasing the odds of getting a "rare" item from opening a fixed number of loot boxes. While not as harsh as a ban, the new laws had a strong impact, forcing many developers to work around them. *Overwatch*, for example, no longer features purchasable loot boxes in the Chinese version of the game, with developer Blizzard instead using a workaround: In-game currency can be purchased instead, with loot boxes received as a "gift."

Other countries have similar rules. South Korea, for example, has restrictions upon developers who wish to include loot boxes in their games: Payout rates must be clearly displayed to the player, and deceptive practices result in a hefty fine. Developers have found their own workarounds to these regulations; the popularity of PC gaming cafes (better known as "bangs") led Bungie to re-examine its Eververse virtual store in the Korean version of *Destiny 2*. Instead of loot boxes and premium currencies, vendor Tess Everis is replaced by Yuna, a vendor who can only be accessed in versions of *Destiny 2* played in PC bangs, and who offers rare weapons and gear to rent for a small fee, acting as a replacement for the loot box model.

In Europe, Belgium led the charge, enacting laws that state that loot boxes are considered games of chance, and therefore are subject to direct legal regulation. Many developers, including Blizzard, Valve, and 2K Games,

MOBILE MICRO-TRANSACTIONS



RoyalOrchid: Okay. Lol.
TheBoredFatGuy is on a 30 win streak in Gold

Get a BRONZE, SILVER, GOLD, or DIAMOND Painwheel!
BUY 10, get 1 RARE BONUS Relic!

Get a BRONZE, SILVER, GOLD, or DIAMOND Fighter!
BUY 10, get 1 RARE BONUS Relic!

Skullgirls* Mobile *does allow players to earn loot boxes through gameplay, but it's easy to skip over that part with a loaded credit card.

A huge part of the loot box market (and the gaming market as a whole) is found in mobile games, where things are even more dire than in mainstream PC and console gaming. While Google and Apple have both passed regulations on their respective app stores to force game developers to publish the odds of rewards from any loot boxes included in their games, the pricing involved is frequently crazy, and many games utilize premium currencies, too, with some packages costing upward of $100. In a free game, no less.

One such example is the mobile port of fighting game *Skullgirls*, which features both a premium currency (dubbed "theonite") and loot boxes in the form of relics that reward random characters and other items. According to regulations, the odds are easily viewable in game, and both relics and theonite can be earned through gameplay, albeit at a hugely slower rate. The game is free to play without any ads, and as such microtransactions represent the sole profit margin for the developers; a fair assessment for gamers, who retain the ability to "vote with their wallets."

The problem, however—and an issue that plagues many mobile games—is that these relics are the primary source of characters and gear that significantly affect gameplay in a game that does have competitive elements, thus giving unfair advantages to players who are willing to shell out the extra cash. There's also the potential upset caused by ongoing balancing from the developers. When a certain character or move is nerfed or buffed to change its performance in game, players who paid to unlock it may feel cheated. The worst possible scenario, as seen in some mobile sports games, is when paid rewards are removed from players' inventories at the end of a gameplay season. This is a strategy that directly targets the "whales," demanding more money when the next season starts if they want to keep using their favorite athlete.

removed paid loot boxes from their games altogether to avoid legal action. Not everyone went down without a fight, however; in May 2018, EA issued a statement that the loot boxes featured in the *FIFA* games did not constitute gambling, which led to a lawsuit from the Belgian Gaming Commission, and ended with EA removing *FIFA's* microtransaction-driven Ultimate Team packs in January this year. The Netherlands has also issued similar rulings, and both nations have called for other members of the European Union to examine and regulate loot boxes. Meanwhile, the Australian government conducted a study in 2018 into the effects of loot boxes on children, concluding that they are a form of targeted gambling and should require an R rating on games that include them.

THE BATTLE CONTINUES

Some countries have yet to take action on loot boxes, although the cogs are starting to turn. The UK Gambling Commission recently ruled (for a second time) that loot boxes do not constitute actual gambling, because the rewards cannot be monetized—a common defense from publishers when looking at loot boxes. This doesn't always ring true, however. While games such as *Overwatch* do not include trading functions or any real assignable "value" to loot box rewards, other games—such as Valve's *Team Fortress 2*—do, enabling the effective monetization of items received from loot boxes. *Counter-Strike: Global Offensive* is one somewhat infamous example here. Some weapon skins are worth a lot of money in the game's player-driven economy. The extremely rare AWP Dragon Lore skin is currently worth around $1,500, and it's not uncommon for *CS:GO* skins to reach above $10,000 in value.

Following a call from the International Game Developers Association, US policy makers have started to pay attention, too. Missouri Senator Josh Hawley is one of the biggest proponents, putting forward his "Protecting Children from Abusive Games Act" (a bit wordy, but keep it up, Josh) earlier this year. He claims that loot boxes "prey on user addiction" and work by "extracting profits from fostering compulsive habits," with a goal of ultimately banning loot boxes from games that are marketed at children. This definition is fairly vague, however, not putting any onus on parents to regulate the games their kids play. Instead, it's targeting any game rated lower than "adults only," taking aim at a vast section of the games industry.

The industry seems to be aware of the noose tightening around its neck. The Entertainment Software Association recently announced that a number of major publishers, including Microsoft, EA, Ubisoft, and Nintendo, will be fully publishing the odds of getting different rewards from loot boxes in their games. Other upcoming games, such as *Halo Infinite*, have received acclaim for stating that there will be no loot box features, while some are going further and removing paid loot boxes altogether, as seen recently in *Rocket League* and *Heroes of the Storm*. These moves toward transparency might appear to some as a halfway house for the industry and regulating bodies; others claim it is an alarm bell signaling the beginning of the death of all loot boxes. Only time will tell, but one thing's certain: We won't be sad to see the loot box go.

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PAYING THE PREMIUM

Premium currencies, for those not familiar with the term, are a form of in-game money purchasable with real-world money, which can be spent on specific items in the game. While premium currencies have been around in games for a while (and, for a brief horrible period, in virtual stores on some consoles), their relationship with loot boxes has grown more complex of late. Some developers have used premium currencies as a workaround to avoid selling loot boxes directly, by having them available to buy in game using a currency that costs real money. Free-to-play title *Warframe* was guilty of this, featuring random mod and relic packs that could be purchased with the premium currency Platinum, although the packs were removed following negative responses from players.

Premium currencies are often purchased via microtransactions, which have the same target painted on their back as loot boxes when it comes to some regulating bodies. Some games, however, do away with all that nonsense altogether, keeping microtransactions, but with maximum transparency, and no premium currencies or randomness, such as the excellent system that can be seen in Respawn Entertainment's *Titanfall 2.* There, cosmetic items were individually priced in dollars and cents; if you wanted one particular weapon paint job, you knew exactly how much it would cost you, and there was no element of randomness involved.

Unfortunately, the likelihood of premium currencies being banned is far less likely, despite many games featuring player-driven economies that are propped up by said currencies. Player-to-player trading applies real-world worth to digital items, as evidenced by the massive loss of wealth seen in some of *EVE Online's* giant multiplayer space battles. While some lawmakers might not like the fact, it seems as though premium currencies—unlike loot boxes—are definitely here to stay.

Developers should strive to replicate the awesome microtransaction system seen in Titanfall 2.

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FACEBOOK'S

The social media giant takes on the finance industry with Libra

BY CHRIS LLOYD

FACEBOOK'S LIBRA is nearing launch, and if the plans bear fruit, it's going to be the most disruptive thing to come out of Silicon Valley for years. Let's start with what Libra isn't. It's not a cryptocurrency, you won't be able to mine coins, and it's not an opportunity for speculation or investment. It does use similar blockchain tech to drive it (see "The Blockchain" box), but it's a closed system designed for stability. It's also designed to be fast, something bitcoin struggles with (it can barely manage

NEW MONEY

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seven transactions a second; Libra will start at 1,000). It isn't a bank account either, something Facebook is keen to stress for legal reasons, so you won't be earning interest on your account, or get credit.

Libra is a stable private blockchain digital currency, and will be accessible through Facebook applications. It is not unlike a PayPal account in operation, but without a link to your bank account. Facebook has developed a subsidiary, Calibra, to handle it. You will be able to store Libra "coins" (or whatever units of Libra are called; it's not clear yet) on the Calibra wallet application, which links into WhatsApp and Messenger. Libra will also be available through Google Play. Once an account is verified using a government-issued ID, you will be able to spend hard cash to buy Libra, either electronically or by handing over actual folding stuff at the planned participating outlets. Facebook is in talks with chains of convenience stores to make cashing in and out readily accessible.

You can then send your Libra "coins" to another Libra wallet, or spend them to pay for goods and services online. Eventually, you'll be able to tap and pay with your phone for your coffee, Uber ride, or whatever you want. You can also cash in your coins, getting hard currency in return. It's not clear yet whether this will involve a fee, although it looks likely. Libra is not meant to be a vehicle you put money into; it has been designed to be used as money itself. There are plans to make it possible to buy Libra at ATMs, too. Any fees will be low, certainly considerably lower than using traditional financial services, although we don't know exactly how low. The Libra website talks of "low or no" fees, and of potential rewards and bonuses for choosing to pay with Libra. As the Libra website says, "Libra's mission is to enable a simple global currency and financial infrastructure that empowers billions of people." That's big talk, but then Facebook does like to frame its projects in grandiose language.

WHEN YOU BUY a Libra coin, what you buy into is the Libra reserve fund, currently backed by assets worth around $1 billion. The reserve fund is held in major world currencies and US Treasury bonds, which are traditionally pretty stable. By spreading the risk, the value of a Libra coin should remain fairly flat. And because you are likely to buy and then spend your Libra coins quickly, any long-term drift is relatively unimportant. Initially, a Libra coin will be worth about one dollar.

Get used to these wavy lines; Libra introduces a new global currency.

Libra will be much more than hipsters tapping phones to pay for skinny whites. All you need is a smartphone, and you have access to banking-like services. That's something that nearly two billion people don't have. Libra can power the kind of micro-transactions that make all the difference in developing countries. The potential market is massive: There are 100 million people in Pakistan alone with no access to a bank account. The market for international remittance is a target, too (see "Sending Money Home" box). Libra has potential to do a bit of good, as well as earn Facebook and friends a lot of money.

Libra may be revolutionary for the financial market, but the technology really isn't. The widespread use of Internet-enabled devices and the development of the blockchain ledger made it inevitable that Libra, or something similar, would appear eventually. Using money on the Internet used to be an awkward process—if you remember a time before PayPal and debit cards, you'll know. Libra is the logical next step, where money is converted into tracked, transferable data, with the blockchain keeping a record of who has how much. Your dollars are free to flash across the world, along with the endless text messages and selfies.

Cryptocurrencies were always a threat to Facebook, as well as a huge opportunity. Facebook's billions are made selling ads to influence what people buy. Any company that developed a successful stable cryptocurrency would threaten that market by building a valuable set of data that tracks spending habits—just what advertisers want. If that company had the reach and power of, say, Google, it could take a sizable bite out of Facebook's business. Libra means Facebook can keep transactions within a controllable suite of Facebook apps, giving even more reason for a business to buy advertisements there.

Most tech enterprises attract little attention from the world at large. Facebook carried on quietly fueling the social media boom for years

THE BLOCKCHAIN

What is the blockchain? It is tempting to say it's a mass of complicated math you don't need to understand. Essentially, it's an electronic ledger that tracks the movements of digital tokens between wallets—apps that store the tokens. The tokens can represent anything: ownership of a share or proof of identity, for example. Each transaction is verified and added to the list, or chain. The wallets have two cryptographic keys, one private and one public. A transaction is encrypted using your private key and the recipient's public key. At the other end, the process is reversed, so it can only be unscrambled by the intended recipient, and they know it's from you. The scrambling involves that complicated math we mentioned. Each transaction becomes part of the whole, because it's mathematically linked to previous transactions, so it's virtually tamper-proof. It's a neat system, which can run on a distributed network (traditional cryptocurrencies) or private systems.

While Libra uses much of the same underlying technology as bitcoin, it works differently. Coins are created as required, and "burned" (destroyed) when they leave the system. This is quite unlike bitcoin, which has a limited number of coins that, in theory, never get burned, although an estimated quarter of all bitcoins have been irretrievably lost. Although it is called the Libra Blockchain, it doesn't use blocks of data, but rather treats the data as a whole. This simplifies things, and speeds it up. It is also the reason why any transition to a distributed model will be very difficult, despite the idea that Libra will be opened out in the future. Facebook has termed Libra as a "decentralized programmable database," although this hardly helps make things clearer. It has been widely reported as having an initial transaction speed of 1,000 per second. If true, it looks a little inadequate, unless there is some batch-processing involved. Visa runs an average of 150 million transactions per day, which equates to around 1,700 a second. Given Libra's expected use for multiple micro-transactions, and the hoped-for size of the user base, it'll need to expand capacity at some point.

The banking world has been employing blockchain technology for years, but hidden away behind the scenes, managing business-to-business transfers, clearing, and settlement transactions between banks, for example. While the adventures of bitcoin, with its crazy valuations, has captured the headlines, back-room blockchain systems have been working their way into the servers of big business.

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Introducing Libra
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Look—you can send money while on the back of a bike. A cheesy, but slick, promo video stresses Libra's simplicity and global nature.

© LIBRA PROMOTIONAL VIDEO

before attracting attention from legislators. The fact that Libra is special is clear when, months before even a limited launch, it attracted comments from the financial chiefs of the G7 nations.

SO, WHY ALL THE FUSS?

Because money is power, and Libra side-steps so much regulation, and that has implications. If Libra gets as big as it plans, it will put a great deal of power into the hands of those who control it. Libra may sound libertarian—many aspects are—but it has the potential to be intrusive, and worse. The prime mover behind Libra being Facebook hasn't helped bring positive reactions either. The company has a terrible record on privacy; only a few months ago, it was fined a record $5 billion for passing on private data. The records generated by Libra will be kept by Calibra, and can't be shared with Facebook's servers without authorization using an opt-in system. However, there are plans for a friend-finder search function, which does require the linking of Calibra transactions with Facebook accounts. The trick, it seems, is to get users to give permission to share information, through incitements of some sort. Collecting data is what Facebook does, and Libra will be part of that process.

Your financial records are a goldmine for advertisers. Can we trust Facebook not to exploit them? In surveys, Facebook does not score well at all. A recent one by NBC and the *Wall Street Journal* had 60 percent of people not trusting Facebook with personal data, more than twice the figure for Amazon. We may not trust Facebook, but we haven't stopped using it. That financial data isn't just a juicy target for business, either—security forces would be very interested, too.

The Calibra wallet app links into WhatsApp and Messenger.

The advent of Libra has drawn a great deal of attention from US Congress, too. Banking is a heavily regulated industry, while tech companies have generally received a light touch. That looks set to change. Facebook has moved into different waters here. In July, the Banking Committee held hearings and questioned the head of the Libra project, David Marcus, for two days. It wasn't the friendliest of meetings. The Senator for Ohio said that the company showed "breath-taking arrogance," and that Libra was "a recipe for more corporate power over markets and consumers." Facebook denies that it is a bank, and therefore is free from bank regulations. Which is just as well, because one committee member said, "If you're a bank, we (will) regulate the heck out of you."

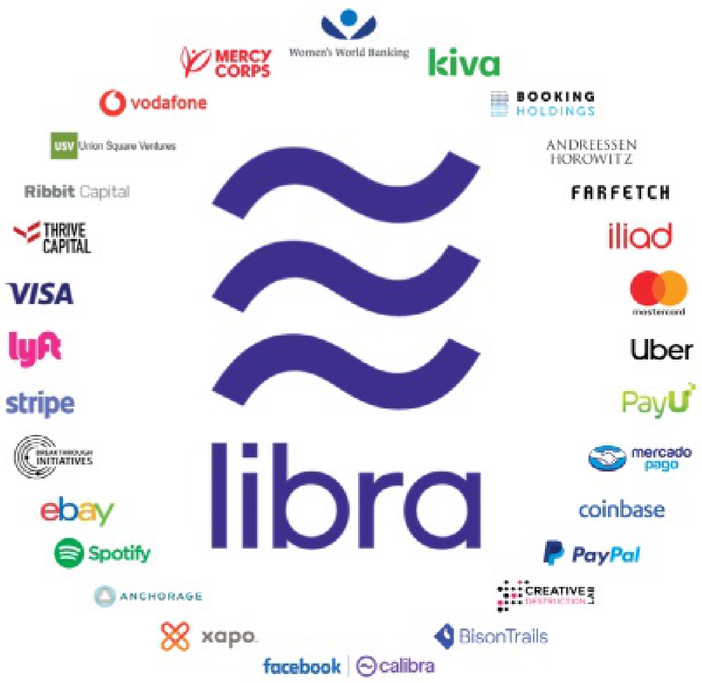
There is not a lot of love for Facebook on Capitol Hill. It has, as yet, failed to give concrete answers on how it will implement anti-money laundering measures. Basing the organization in Switzerland has drawn heavy fire, too (see "The Libra Organization" box.) Mr. Marcus claims the location was chosen to give Libra an "international place," not to skirt regulations. Facebook has also said it won't launch Libra before the regulatory issues have been resolved.

IT'S NOT JUST IN AMERICA

that Libra faces problems. The French financial minister, the governor of the Bank of England, and the Swiss Data Protection Commissioner have all issued statements that warn of the need for regulation. Many countries have laws banning or limiting the use of cryptocurrencies; one huge market Libra was hoping to hit early was India, where such laws have blocked its launch for now.

The potential for criminal use is another frequently raised concern. There are tight banking regulations to stop money laundering—what does Libra have? Promises—

THE LIBRA ASSOCIATION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Facebook will not run Libra directly, but through its subsidiary Calibra, it will be a partner in the body that does: the Libra Association. This is a non-profit, independent organization dedicated to running, controlling, and promoting Libra, as well as managing the reserve fund. Facebook hasn't gone alone for a number of reasons, trust being one of them. As the project leader David Marcus admitted, "If we were controlling it, very few people would want to jump on and make it theirs." The association has 28 founding members, and among them are such big names as PayPal, MasterCard, Visa, eBay, Uber, and Spotify. There are also some names you won't know, unless you are familiar with blockchain development and venture capital. This is just the initial lineup—it is expected to grow to over a hundred members by the time Libra goes live.

Each founding member paid in at least $10 million to get a seat at the table. Decisions on the running of Libra are made by voting, with no single member getting more than one vote or 1 percent of the total votes (whichever is the greater). The idea is that Libra cannot be dominated by a few of the larger members (in theory, anyway). Each founding member is responsible for running a validator node, which maintains the integrity of the blockchain. Members will also earn interest on cash held in the system—Libra coins, or tokens, created, but as yet unspent—which could become a useful amount if the system grows as hoped. It is also used to pay for running the blockchain: server time costs.

The Libra Association is based in Switzerland. Why? Because Switzerland is a major hub for international money transfers, and Swiss banking laws are unlike any other, and notorious for their secrecy. Swiss banks were also notorious for money laundering, particularly after World War II. Thankfully, the country has cleaned up considerably since, but is still seen as one of the safest places in the world to store money. It is estimated that a quarter of all global cross-border assets are held there. Libra is expected to be regulated by the Swiss financial regulator, although it is still in preliminary talks, and has yet to reply to the Swiss privacy regulator when asked to provide details on its operations.

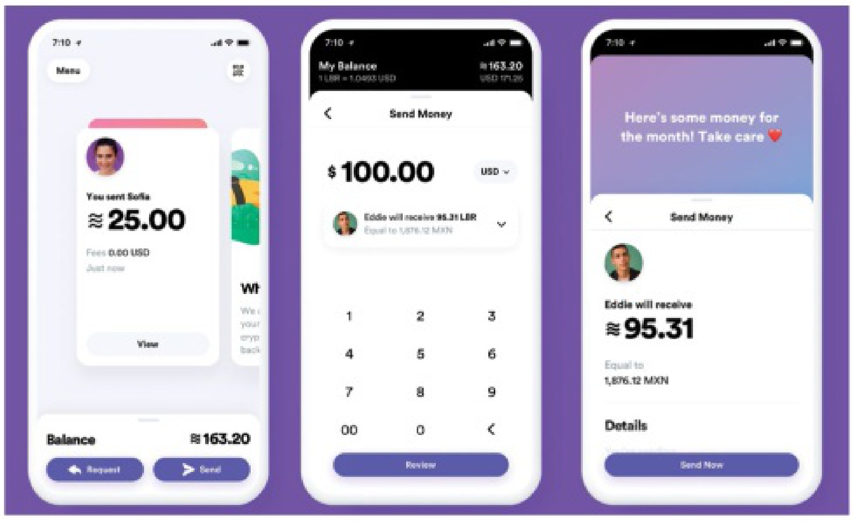
and rather vague ones so far. Although regulated by the Swiss government, it says it will comply with all US tax, money-laundering, and fraud regulations. These include registering with FinCEN (Financial Crimes Enforcement Network), which aims to stop terrorist funding and money laundering by analyzing data collected during financial transactions. It will also comply with the international anti-money-laundering regulations (AML). These include confirming people's real identities, and sending the identity of wallet-holders to the relevant government agencies. Facebook has also applied for an export license, and jumped through a number of other legal hoops. This hasn't stopped calls for the project to be stopped until every concern has been addressed, though.

FACEBOOK CLAIMS that outdated financial regulations have restricted commerce—for example, the banning of the majority of banks to trade in cryptocurrencies. It says that Libra offers real innovation, freeing capital quickly and easily anywhere it is needed, rather than being stuck in the banking system, which can take days to make a simple transfer. Exactly how Libra will be regulated has yet to be resolved. Whether or not it is treated as a bank or as an exchange-traded fund will make a big difference. Facebook says Libra will complement existing financial systems, and it isn't a bank, because it does not interact directly with its users. A moot point, which will probably require lawyers to unravel.

We can expect some more toing and froing, but it will take more than a few Representatives publishing open letters calling for Facebook to halt the project to stop this train. However, this is the biggest ever company to get involved in cryptocurrency, and on such a large scale. We can expect an unprecedented level of scrutiny before launch, which will have ramifications right across the world, and on any future such project.

Cryptocurrencies are often subject to scams and hacks, which have cost coin exchanges millions. Libra will not be immune; it uses open-source software and allows for third-party wallet applications, which can cause problems. Already, there are reports of dozens of fraudulent pages on Facebook and Instagram offering to sell Libra, often at a tempting discount. Facebook is taking them down, but it is a game it cannot ever really win.

It's difficult not to see the irony here—Libra involves real money, where trust is paramount, and the world of Facebook is awash with fakers of various hues. The very platform that Facebook uses to promote Libra is not trustworthy itself. About 5 percent of all active Facebook accounts are fake. Earlier this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The Libra wallet app, Calibra, in action. You can send money as easily as a text (almost, anyway).

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Introducing Libra
Watch later
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The Libra Association is keen to stress its use for sending small amounts of money internationally.

© LIBRA PROMOTIONAL VIDEO

SENDING MONEY HOME

A stated early target for users of Libra is the migrant worker who sends money home to support their family. While the individual amounts may not be large, the scale of the whole business is huge. The World Bank estimates that $715 billion is moved around the world annually, supporting over 800 million people, and making major contributions to the economies of many nations. The established wire transfer services, such as Western Union, take a cut of this. The global average for transfer fees is 7 percent, which is quite a hit: Seven bucks for every hundred of hard-earned wages disappear when you simply send money home. There are currently few ways to avoid these fees, and they have a disproportional effect on wealth. UNESCO (the United Nations Educational, Scientific, and Cultural Organization) has called for this to be reduced to a maximum of 3 percent to aid the developing world.

The infrastructure Libra needs is in already place—the use of smartphones is high, even in countries that lack other basic services. It's not unusual for more people to have smartphones than have access to a bank account. A quick bit of math also shows why this is such a tempting project for Libra. If Facebook manages to capture half of the market, and charges a more reasonable 2.5 percent, that equates to nearly $9 billion a year. This is one reason why it had been planned to launch Libra in countries such as India early, although this has hit a regulatory roadblock for now. Offering free or low-fee money transfers is also an excellent way to get Facebook into emerging foreign markets.

year, Facebook attempted a clear-out, and deleted a staggering 2.19 billion accounts. Although many were profiles and removed at the point of creation, it is still an alarming number. Facebook will have to get much better at identifying and removing fake Libra pages and ads. It has been here before, too—there were so many scams involving cryptocurrencies that it banned all ads for them in January last year. It relaxed the rules a little this spring, allowing related products and services to be promoted, but you still can't sell cryptocurrencies or ICOs (initial coin offerings) on Facebook.

CAN IT ALL GO HORRIBLY WRONG? That is a frightening, if unnecessarily pessimistic, prospect. If it did start to wobble, who would bail it out? No government is under any obligation to do so. Some doom-mongers say Facebook is at risk of developing a system that is too big to fail, but is decentralized to the point where there is nobody obliged to catch it if it does. There is little need to worry unduly, though—Facebook will have done its research thoroughly, and the project is clearly well funded, and has a powerful group of backers.

Libra is going to be big. It is also going to hurt the core business of many large international organizations, as such disruptive technology has a habit of doing. However, it is also almost inevitable. If not Facebook, then somebody else, and Libra is unlikely to have the market to itself for long either. Ready or not, such currencies are coming. Libra should be ready to launch next year, although exactly where and what service it will initially offer is unclear. In the meantime, there is going to be a good deal of sorting out, as the regulators and Facebook bargain over exactly how Libra is to be regulated and implemented. In a few years, we will probably be wondering what all the fuss was about. The basic idea is solid, practical, and genuinely useful: a stable world currency designed from the outset to be used in a digital world. ⏻

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1 AMD RYZEN 3 3200G

Checking in at just $100 and with a potential maximum clock of 4.0GHz, this dinky quad-core chip comes equipped with AMD's own Radeon Vega 8 integrated graphics, making it the perfect processor for an affordable build, whether you're going to use it for office work or cryptocurrency mining.

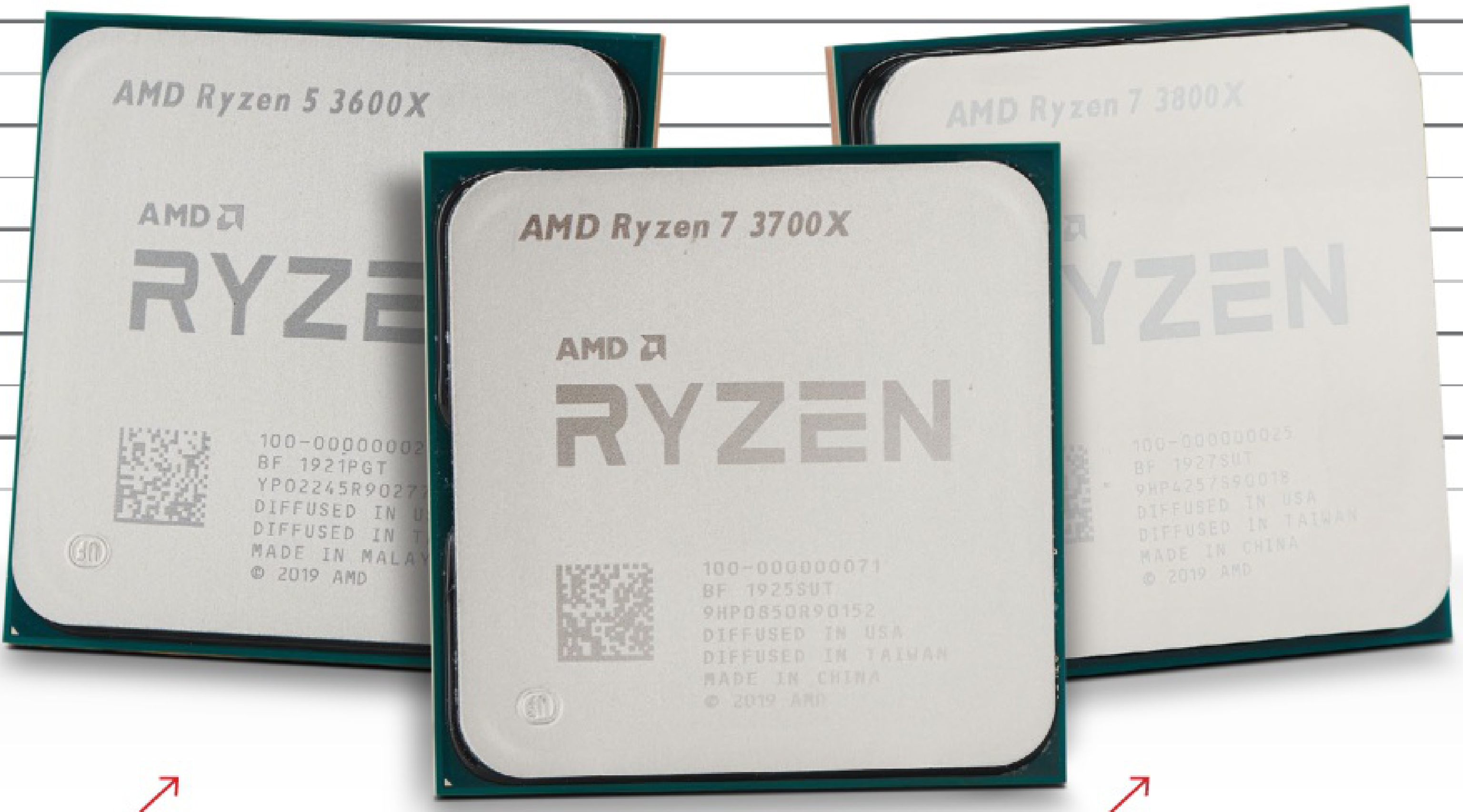
2 AMD RYZEN 5 3400G

The first Ryzen 5 processor in the 3000 series, the 3400G represents a significant step up from the 3200G—albeit for 50 dollars more. Integrated Radeon Vega 11 graphics, a 4.2GHz boost clock, and the chunkier Wraith Spire cooler mean that this processor can handle heavier workloads without the need for a discrete GPU.

3 AMD RYZEN 5 3600

There are no integrated graphics to be seen here, but this $200 processor offers 12 threads and 32MB of L3 cache, making it a good middle ground for anyone looking to build a new system. It comes packaged with the smallest Wraith cooler of the lineup (the Wraith Stealth), so you might want to upgrade to a new cooling solution.

THE NEW SERIES of Ryzen CPUs has hit the ground running. After a few teething issues with existing systems and programs (looking at you, *Destiny 2),* these CPUs are ready to roll. Improving on the second generation across the board, the new 3000-series processors come with their own coolers, while maintaining a price point that keeps them competitive with Intel's offerings. Thanks to PCIe 4.0 support, these CPUs can form the basis for the fastest, smoothest systems around. AMD isn't leaving those on a tighter budget behind, either. With prices ranging from $100 to $500, there are options for anyone putting together a new build. You might notice that the high-end Ryzen 9 3900X is absent from this lineup—that's because we've already reviewed it, and it was great.



4 AMD RYZEN 5 3600X

A straight upgrade to the Ryzen 5 3600, the X variant is capable of reaching slightly higher clock speeds than it's little brother, but otherwise doesn't change much. It does, however, come with a larger cooler, ready to deal with the additional heat produced by overclocking. A good choice for enthusiasts on a budget.

5 AMD RYZEN 7 3700X

Now we're getting to the really good stuff. The price jumps up pretty sharply once you hit the Ryzen 7 processors, but they're still good value: Eight cores, 16 threads, and the sweet RGB effects of the Wraith Prism cooler mean that this is a quality processor, and one we think we'll be seeing a lot of in system builds.

6 AMD RYZEN 7 3800X

The 3800X is another straightforward upgrade; this time, it's building on the 3700X. While overclocking on this processor isn't easy, it's hardly necessary, thanks to a mighty 3.9GHz base clock. The thermal design power leaps up from 65W to 105W with this one, though, so you need to be prepared to take the hit on your overall system cooling.

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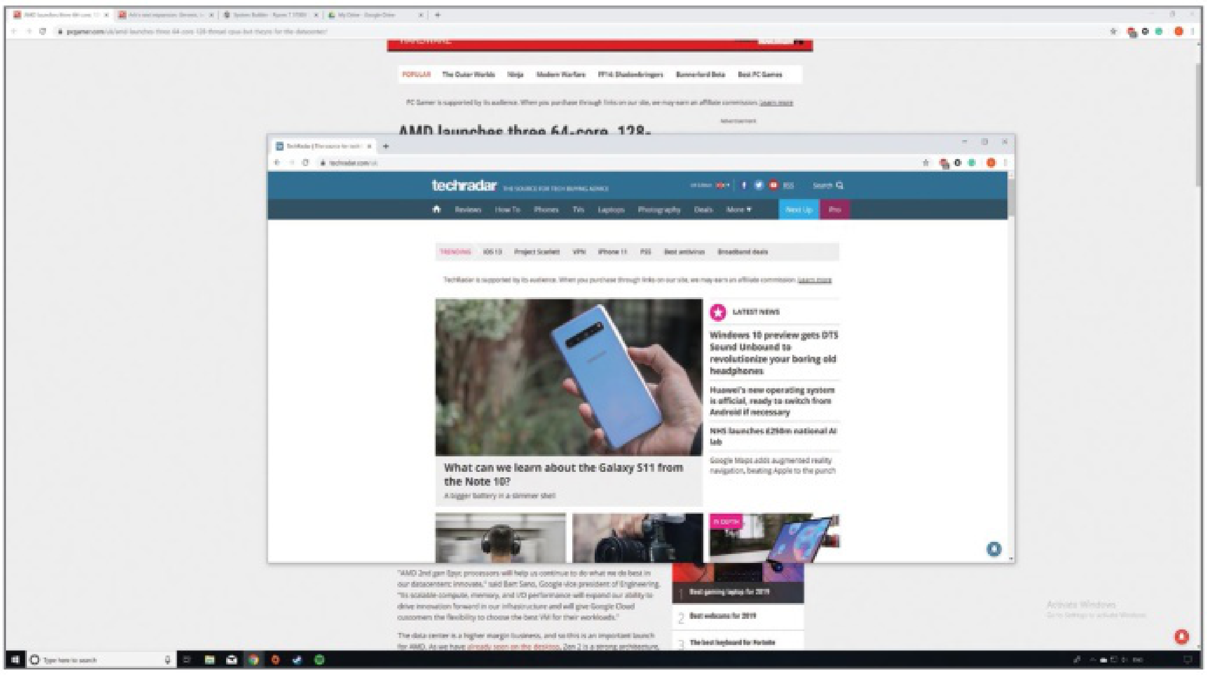
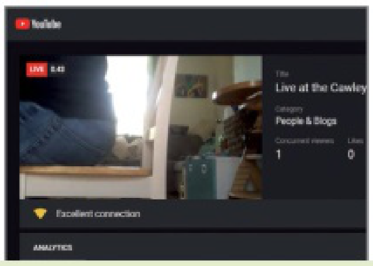


SHAKE IT UP

Too many tabs open at once for your liking? Well, there's a simple solution: Use your cursor to grab the title bar of the application or page you want to focus on, and give it a good shake. Thanks to a nifty motion feature in Windows 10, this instantly minimizes all your other open windows. Plus, the angry shaking of a program you're supposed to be working on feels oddly cathartic.

MAKE – USE – CREATE



56
Stream to YouTube from your Raspberry Pi

60
Test your GPU using Nvidia FrameView

68
In need of a new rig for editing video? Look no further

CHRISTIAN GUYTON
STAFF WRITER

TOTALLY RAD(EON)

This month, it's all about the new Radeon gear. We've got our grubby mitts on both new GPUs—the RX 5700 and RX 5700 XT—along with a selection of Ryzen 3000-series CPUs. We're loving them, too. The RX 5700 in particular impressed, just about matching the in-game performance of Nvidia's GeForce GTX 1080 at less than half the price. It's a staggeringly good card for 1080p and 1440p gaming, and I've found myself looking at it longingly on its perch on the top shelf of our stock cupboard.

Choosing a GPU right now is tricky. If you're on a budget, factory overclocked models of the RX 580 and RX 590 are still available at incredibly low prices. If you've got a bit more money, you may be deliberating between the RX 5700 or the RTX 2060 Super, or even the RTX 2070 Super. For 4K gaming, the older 2080 Ti still rules the roost. That puts the RX 5700 in a slightly odd middle ground between the budget cards and more powerful 1440p cards.

That isn't a bad thing, though. For just $350, the RX 5700 is still perfectly capable of cracking 60fps at 1440p ultra in many games, more so if you don't mind dropping the settings a little. Yes, the XT version is still better, but for a mid-range build, I'd find it difficult not to recommend.

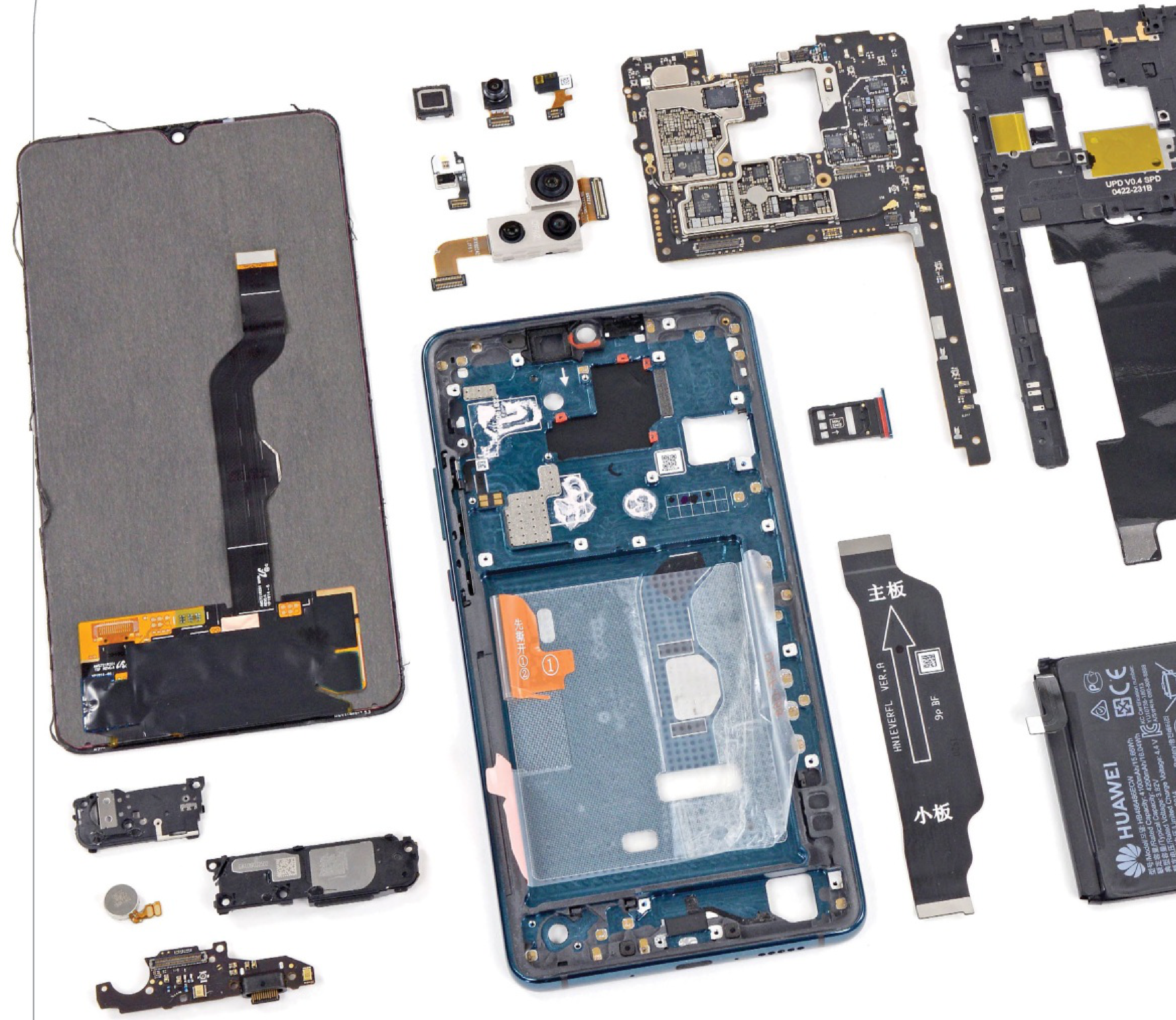
↘ submit your How To project idea to: comments@maximumpc.com

IFIXIT presents:

AUTOPSY

THIS MONTH WE DISSECT...

Huawei Mate 20 X 5G


UPD V0.4 SPD
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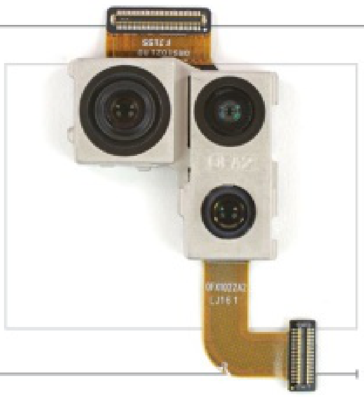
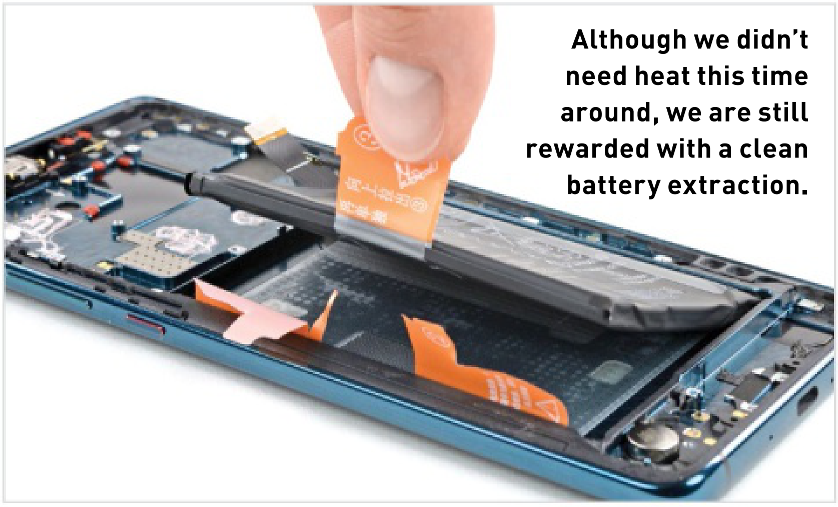


This triclops carries the same technology as the Mate 20 Pro.



Although we didn't need heat this time around, we are still rewarded with a clean battery extraction.

About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit www.ifixit.com.

BACKGROUND

While the US-China trade dispute drags on and we ponder Huawei's future, the company charges into the 5G arena with its new Mate 20 X 5G. We're curious to see what this plus-sized phablet conceals, and how independent the hardware might be—even as Huawei faces the possibility of being banned from doing business with US companies.

MAJOR TECH SPECS

- 7.2-inch 1080×2244 OLED multitouch display
- Octa-core Huawei Kirin 980 chipset, with 8GB RAM
- 256GB onboard storage
- Balong 5000 multimode 5G modem
- 4,200mAh battery with 40W SuperCharge 2.0 support
- Triple rear cameras: 40MP f/1.8, 20MP f/2.2, and 8MP f/2.4 lens with 5x optical zoom

KEY FINDINGS

- On the bottom we recognize the usual suspects: a USB-C port, two mic holes, and a speaker grille. Along the top, we find another mic hole, the infrared blaster, and a sliver of a grille for the earpiece speaker. Compared to the already-large Mate 20 Pro, the X 5G looks colossal. On the back, we note the fingerprint sensor beneath the camera array. Although this Mate is only rated IP53, the SIM card tray is equipped with a rubber gasket—something we usually see on "waterproof" smartphones. To our surprise, we get the glued-down back cover off lickety-split—no heat required.
- A generous fingerprint flex cable keeps the back cover tethered for now, but it's so long that we don't mind. A flock of screws hold the NFC coil, antenna, and graphite heat conductor pad in place. With those out of the way, we can disconnect the fingerprint sensor and get our first good look inside. The 24MP front-facing peeper comes out with a simple pry. We'll never grow tired of repair-friendly press-fit connectors. The mobo also comes out easily, allowing us to unplug the three-eyed rear camera block.
- It looks like the 5G modem comes with its own block of LPDDR4X memory. To access the battery, we remove the board interconnect cable. We also pry up the glued-in loudspeaker, and the daughterboard with the USB-C port.
- We follow the built-in battery removal instructions step by step. This is the same battery used in the Mate 20 Pro, weighing in at 16.04Wh. That's a monster compared to the iPhone XS Max's dual-cell 12.08Wh powerplant.
- The display adhesive holds on tighter than the back cover adhesive, but gives way after some heat and halberd slicing. There's no fancy under-display fingerprint sensor, just a blank OLED screen and the aluminum frame. As in the standard Mate 20 X, there's a big vapor chamber hiding on the aluminum frame behind the graphite foil.
- Repairability score: 4 out of 10 (10 is easiest to repair). Many components are modular and can be replaced independently. The battery is accessible after removing the rear cover and midframe, and has pull tabs. Standard Phillips screws are used along with an average amount of adhesive. The midframe covers the battery and fingerprint sensor connectors, and is obstructed by camera sensors and flash. Glued-down front and back glass means more risk of breakage, and makes all repairs difficult to start. Screen repairs will require near-complete disassembly. ⏻

Stream Live to YouTube from Your Raspberry Pi

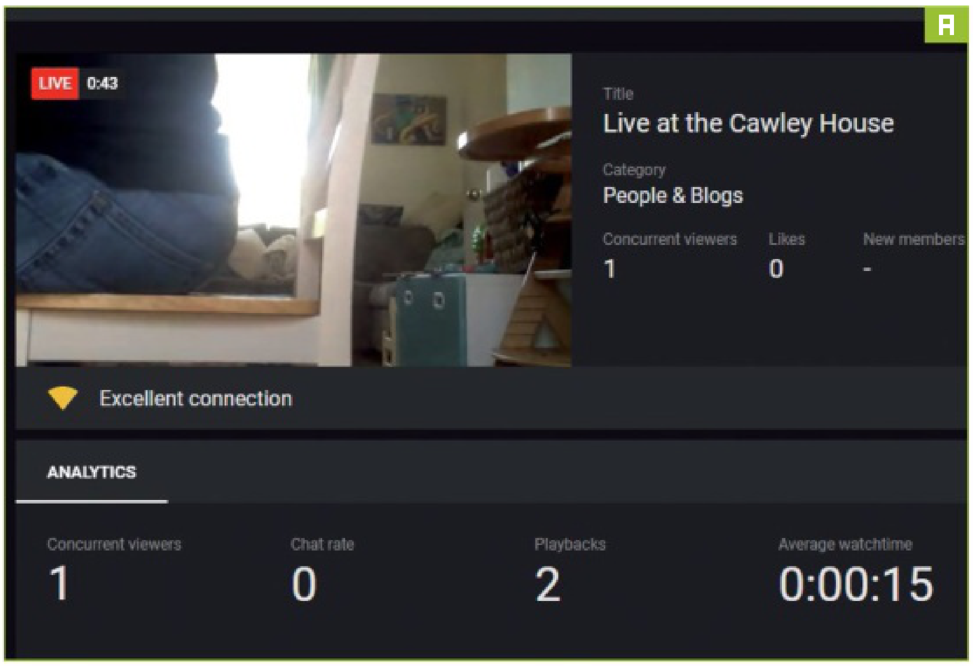
YOU'LL NEED THIS

RASPBERRY PI
You also need the Pi Camera Module.

STREAMING VIDEOS on the web is increasingly popular, and YouTube is the chosen platform for many. Almost any device can stream video to YouTube, but what if you want a dedicated streaming solution? The Raspberry Pi is a great choice for this, giving you the option to stream anything you like, just as long as there is an unlimited network connection.

You're limited only by your imagination, with the Raspberry Pi and its Camera Module ideal for everything from a YouTube-based baby monitor to running live presentations (see the boxout on the opposite page for more ideas).

With a good network connection, the right Raspberry Pi setup, and a YouTube channel stream URL, you can have your Raspberry Pi YouTube-streaming video camera up and running in just a few minutes. –**CHRISTIAN CAWLEY**



Title
Live at the Cawley House
Category
People & Blogs
Concurrent viewers 1
Likes 0
New members -
Excellent connection
Concurrent viewers 1
Chat rate 0
Playbacks 2
Average watchtime 0:00:15

1

STREAMING ESSENTIALS

Before you even pick up your Raspberry Pi, it's a good idea to ensure your network is up to the task. The optimum bitrate for YouTube videos [**Image A**] from the Pi is 400–600Kb/s. You can change this if necessary, but your router needs to be up to the job. Help things along by moving the Pi closer to the router, using an Ethernet cable if necessary, or employing powerline adapters to improve signal strength at your Raspberry Pi's location.

›› While you don't necessarily need a wireless Pi, the best results can be enjoyed with a Raspberry Pi 3, 3B+, or 4. The improved spec of these three over the Raspberry Pi 2 results in superior streaming performance. The Pi 2 will work, but you may run into resource bottlenecks. Tweaking that bitrate (you'll find out how later) will help if you're stuck using one.

›› Your choice of camera may impact how well this works. USB cameras, while compatible with the Pi, are largely pointless, because the computer has such a good official camera. We used the Raspberry Pi Camera Module v2.1 for this project, but the older models should work just as well. If you're planning to add audio to your camera stream, you'll also need a microphone, of course. The best option here is to use a Raspberry Pi-compatible USB mic, although anything connected to a suitable HAT will work. Don't use the TRRS port, however, because it won't work. Raspberry Pi audio is beyond the scope of this tutorial, so we're continuing with a silent video.

2

WE HAVE A STREAM

The Raspberry Pi Camera Module must be connected before you power up the computer. If you haven't done this before, find the camera port, then lift the catch. Insertion is straightforward: The rule of thumb to remember is that the silver side of the contacts point toward the HDMI port. Before booting up, it's also a good idea to connect the microphone ready for configuration later on.

›› With the Raspberry Pi up and running, you need to configure the Camera Module. You can do this either in the Raspberry Pi Configuration screen in the desktop environment, or via the raspi-config tool in the command line if you prefer:

```
sudo raspi-config
```

›› Whichever method you choose, you need to display the Interfacing Options and set the Camera to "Enabled." Select "OK" to confirm and reboot the Raspberry Pi when prompted. Next, you need to confirm that the camera is working. Use the `raspistill` command in the terminal:

```
raspistill –o image.jpg
```

›› This creates a file called "image.jpg" in the "/home" directory. You can check it has been created by listing the directory contents:

```
ls
```

›› In most cases, the camera image will be fine. To check it properly, you need to plug your Pi into an HDMI display, or check via VNC.

›› For streaming to work, you need a YouTube account and a unique key that is created for each stream. If you have a Google account, you probably already have a YouTube account, too, so sign into YouTube, and find the camera icon, click it, and select “Go Live.” In the “New Stream” window, give the feed a suitable title, set a “Public/Unlisted/Private” option, a description, and a genre, then click “Create Stream.” The “Stream Preview” window now appears, displaying the standard stream URL and the stream name/key. You’ll need this, so click the visibility icon, and make a note of the key for later [**Image B**].

3
STREAMING SPECIFICS

To create a video stream, you should have the avconv software installed. This comes pre-installed in Raspbian Stretch, so if you’re using an older version, it’s wise to update it first:

```
sudo apt upgrade
sudo apt update
```

›› If you don’t want to do this (perhaps because you’ve got deprecated software that you don’t want to stop using), simply install avconv as part of the libav-tools package instead:

```
sudo apt install libav-tools
```

›› Creating the stream requires the input of a long `raspivid` command, consisting of various switches and instructions, such as `fps` to set the frames per second. As it’s quite a complicated command, it’s worth looking at some of its key elements.

›› `-fps` As noted, this sets the frames per second captured by the camera. Anything over 24fps should be fine; less than this, and it may resemble time-lapse. A lower rate can improve streaming, however.

›› `-w <xxx> -h <xxx>` Specifies the width and height of the video. Without these, raspivid defaults to 1920x1080 HD.

›› `-b` The output bitrate limit, which YouTube recommends should be 400–600Kb/s. A lower figure means a lower-quality video, but better streaming.

›› `-acodec` If you’re not using a mic, you need to include this. YouTube doesn’t permit videos without audio (or audio without video), so this command creates a fake audio track. If you have a mic connected and working, you can omit this.

›› `-f` The output format. For streaming video from YouTube to the Raspberry Pi, FLV is the best option.

4
KEEP ON STREAMIN’

If you’re setting this up over SSH, it’s a good idea to take steps to avoid the stream closing when you disconnect. One way of avoiding this is with `screen`:

```
sudo apt install screen
```

›› Wait while it installs, then reboot the Pi:

```
sudo reboot
```

›› Connect again over SSH, then enter the `screen` command. You can then run the `raspivid` command. Note that this should be entered as a single line, like so:

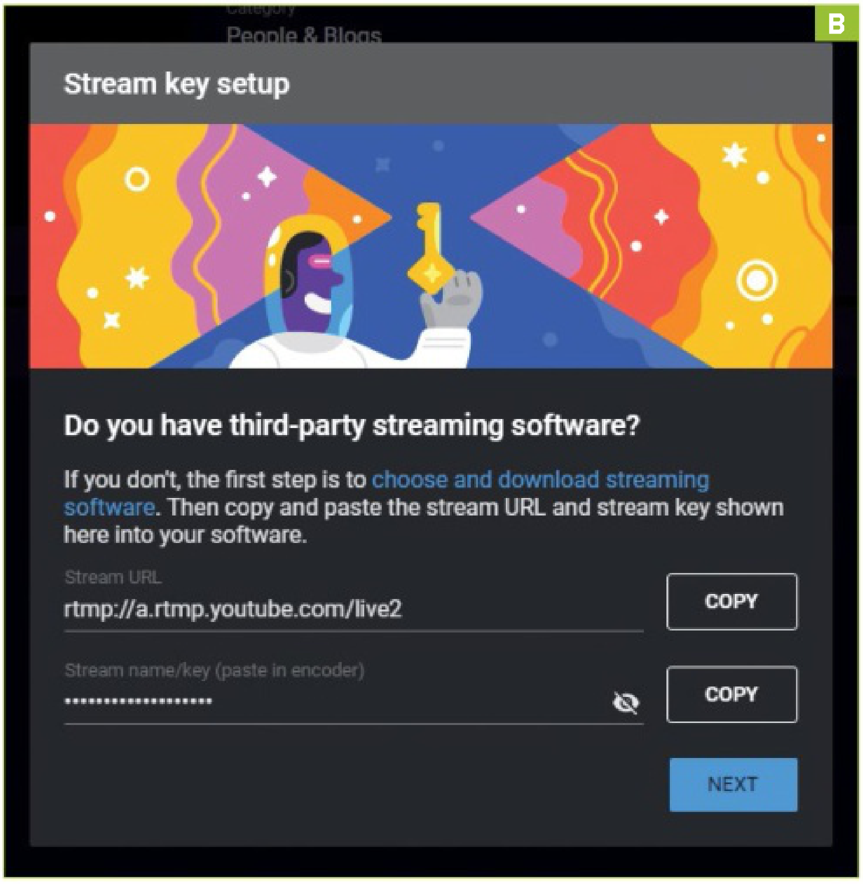
```
raspivid -o - -t 0 -vf -hf -fps 30 -b 6000000 | avconv -re -ar 44100
-ac 2 -acodec pcm_s16le -f s16le -ac 2 -i /dev/zero -f h264 -i -
-vcodec copy -acodec aac -ab 128k -g 50 -strict experimental -f
flv rtmp://a.rtmp.youtube.com/live2/[your-secret-key-here]
```

›› Simply copy the YouTube stream key from the browser window into the terminal, replacing `[your-secret-key-here]`. Press Return and wait while the stream starts. A moment later, you should see it running in the top-left corner of the YouTube livestreaming page. If nothing happens, double-check all the setup steps as listed above.

5
CROSSING THE STREAMS

With the stream running, you can share it or simply watch it. Using a private channel for the feed at the setup stage lets you limit the feed to YouTube apps or browser sessions with the corresponding account details. Otherwise, the feed will be public or unlisted.

›› With both options, you can share the feed with others. The public feed is open to anyone, whereas the unlisted feed is limited to those who have the feed URL; it isn’t displayed in search results. Both options enable you to share the feed URL on your preferred social networks as well. ⏻



Stream key setup

Do you have third-party streaming software?

If you don’t, the first step is to choose and download streaming software. Then copy and paste the stream URL and stream key shown here into your software.

Stream URL: rtmp://a.rtmp.youtube.com/live2

Stream name/key (paste in encoder): ••••••••••••••••••••

USES FOR LIVESTREAMING

Why might you want to stream video with a Raspberry Pi? Various uses can be considered, although some will be impacted by latency, which can be as much as 30 seconds once the video has been captured, sent, and uploaded to YouTube.

For example, you could set up the Raspberry Pi as a baby monitor. Configuring the YouTube feed as private means that you can keep an eye on your little ones from any portable device, just as long as you’re signed in with the same account.

Alternatively, you might use the Raspberry Pi as a security camera. Again, a private channel can let you watch your home from any location you can get a signal. While it will miss the benefits of a standard IPTV security camera (such as motion detection), it makes an adequate substitute.

Other problems can be solved with a Raspberry Pi streaming video camera. You could go public with your YouTube video feed, perhaps making short livestreams to share your thoughts about recent topical events. You could demonstrate your job, your work setup, or even a hobby you enjoy; you might even conduct an AMA with your Raspberry Pi as the stream host, direct to YouTube.

Master Cortana with Key Commands

YOU'LL NEED THIS

WINDOWS 10
Your device also needs a microphone if you want to speak to Cortana instead of typing commands.

FOR SOME USERS, especially those used to versions of Windows previous to 10, Cortana is something of a non-event. Why would you want to use an AI assistant to do something you could very well do yourself?

These people have probably never experienced the joy of using an Amazon Echo to switch the lights on and off, and the two things are very similar: Cortana exists to make things easier, to smooth your passage through Windows' interminable screens and pop-ups, and to put a friendly face on technical settings.

We're using typed commands, but you can also talk to Cortana if your Windows device is equipped with an appropriate microphone. To ready Cortana to accept voice input, you can press Win-C or a dedicated search button, click the mic icon near the system tray, or say "Hey Cortana!" if you've enabled it (see boxout). Let's get started. –IAN EVENDEN

1 SEARCH AND LAUNCH APPS

Opening Cortana and typing gives similar functionality to typing on the Start menu—it searches your PC, bringing up documents and apps that match your parameters [Image A]. It's using speech recognition that improves things here, because saying "Hey Cortana, open Excel" will plunge you into a fun world of spreadsheets. It might not be any faster than just clicking an icon, but it feels futuristic.

2 SEARCH THE WEB

You can give Cortana more context for the search if necessary—for example, you can narrow things down with "documents from the last week." If Cortana can't find what you want on your PC, it resorts to an Internet search, in this case using Bing, with results opening in Edge. If you type your query, it will happen when you press Enter, or you can say "Hey Cortana, find me pictures of puppies" to see small dogs from the web [Image B].

3 CHANGE SETTINGS

Type in "increase volume" and Cortana will point you to the audio properties section of the Settings app [Image C]. However, if you say "Hey Cortana, increase the volume" while you're watching a movie, she will helpfully make it louder for you. The same goes for things such as turning Wi-Fi on and off, or any other simple settings change you can think of, such as "open lock screen settings" or "activate battery saver."

4 NEWS AND WEATHER

Typing "news" or "weather" into Cortana's search box will suggest the appropriate apps from the Microsoft Store, launching them when you press Enter, and using your location to tailor the results appropriately [Image D]. You can refine it further, asking for the weather in a specific city or region, or a forecast for a particular day. News can be filtered by topic, or you can ask for the score in a sports game.

5 REMINDERS AND ALARMS

Saying "Hey Cortana, set an alarm for Monday at 5.30 a.m." will get you out of bed unreasonably early, and you can also make it every day, or every Monday, as you choose. "View alarms" shows you what's already set, and "cancel" followed by the alarm details will do just that. "Hey Cortana, remind me to go to the gym at 6 a.m. on Monday" will pop up an on-screen notification at that time, rather than sounding an alarm [Image E].

6 ADD CALENDAR EVENTS

You can place new events in your calendar using Cortana, but you must give her access to it first. The first time you ask Cortana to manage your calendar, she asks for permission, then asks for the subject, date, and which calendar you want it added to [Image F]. Then you can ask "Hey Cortana, how's my schedule today?" or "Add dentist's appointment to 2.30 p.m. on Tuesday."

7 RECOGNIZE A SONG

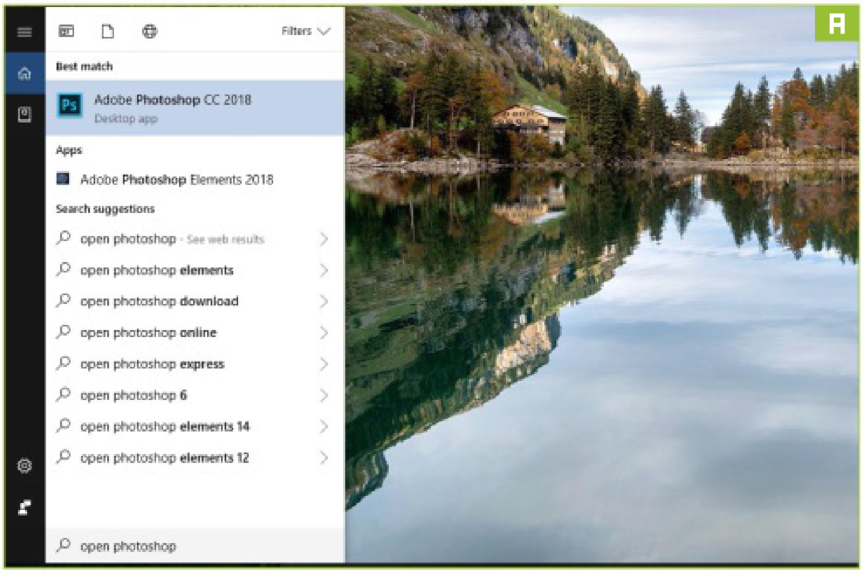
If you want to know what's playing on the radio, type the station name and "now playing" into Cortana to get a Bing result [Image G]. If there's music playing on your PC, you can say "Hey Cortana, what's this song?" for an answer. She can use your PC's microphone, too, listening to a song playing for a short while before guessing what it is. Ask for a song or artist, and she will look in your music library.

8 LOCK, RESTART, OR SHUTDOWN PC

If you use your PC as a late-night media player, being able to shut it down with a voice command means you can stay in bed. Say "Hey Cortana, shut down my PC," or ask for a restart, and she will ask for confirmation [Image H]. Answer "yes" and shutdown will continue, say "no" or "cancel" to stop it. If you want to lock your PC, ask Cortana, and she'll do it straight away, with no confirmation. ⏻

HELLO, IS ANYONE THERE?

If you want to make the "Hey Cortana!" voice command work, you first have to enable it—simply go to "Settings → Cortana → Talk to Cortana → Hey Cortana."


A
Filters
Best match
Adobe Photoshop CC 2018
Desktop app
Apps
Adobe Photoshop Elements 2018
Search suggestions
open photoshop - See web results
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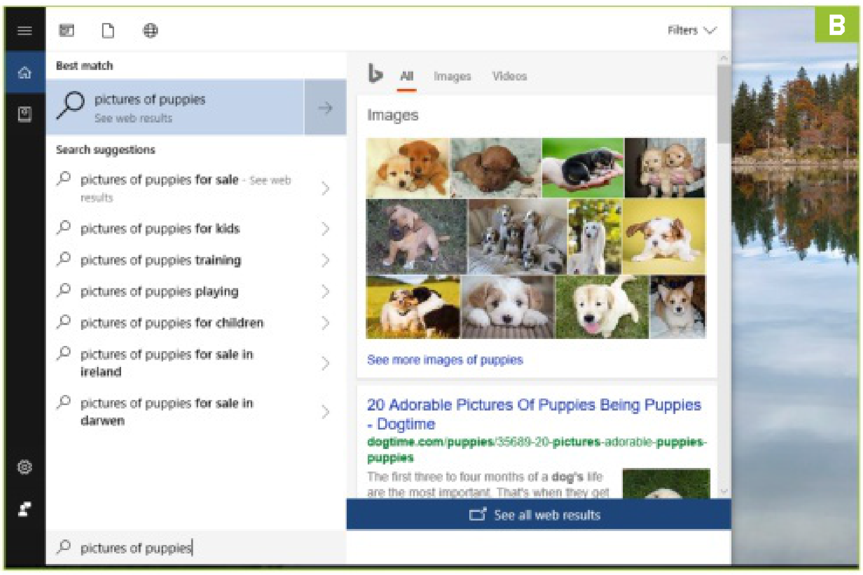
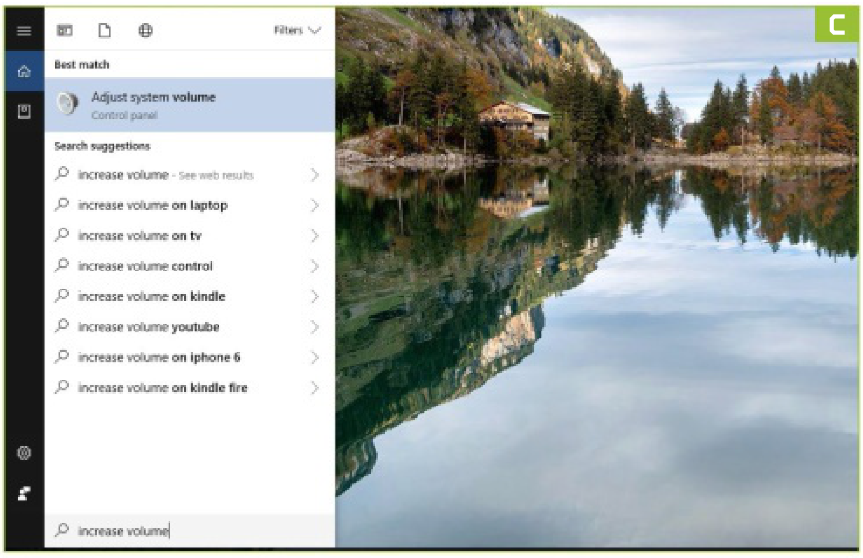
open photoshop download
open photoshop online
open photoshop express
open photoshop 6
open photoshop elements 14
open photoshop elements 12

open photoshop

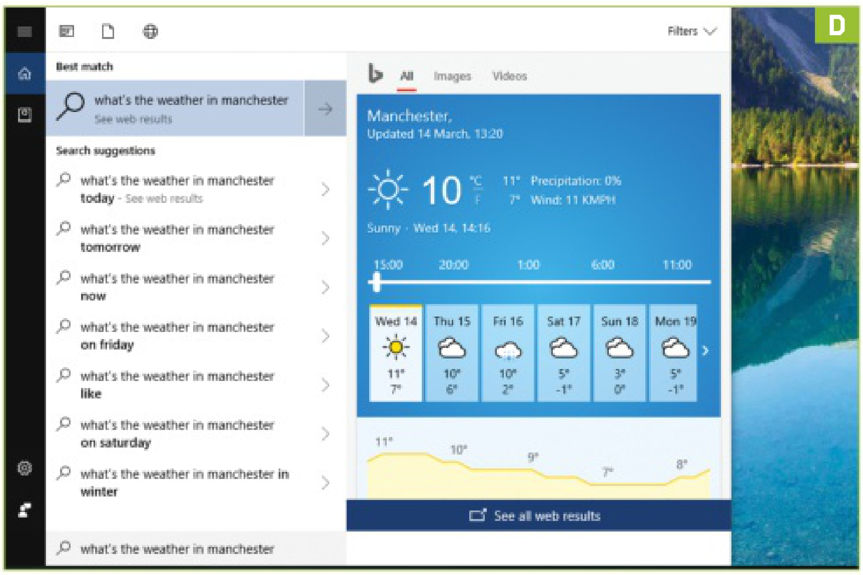

B
Filters
Best match
pictures of puppies
See web results
Search suggestions
pictures of puppies for sale - See web results
pictures of puppies for kids
pictures of puppies training
pictures of puppies playing
pictures of puppies for children
pictures of puppies for sale in ireland
pictures of puppies for sale in darwen
All
Images
Videos
Images
See more images of puppies
See all web results

20 Adorable Pictures Of Puppies Being Puppies - Dogtime
dogtime.com/puppies/35689-20-pictures-adorable-puppies-puppies
The first three to four months of a dog's life are the most important. That's when they get

pictures of puppies


C
Filters
Best match
Adjust system volume
Control panel
Search suggestions
increase volume - See web results
increase volume on laptop
increase volume on tv
increase volume control
increase volume on kindle
increase volume youtube
increase volume on iphone 6
increase volume on kindle fire

increase volume

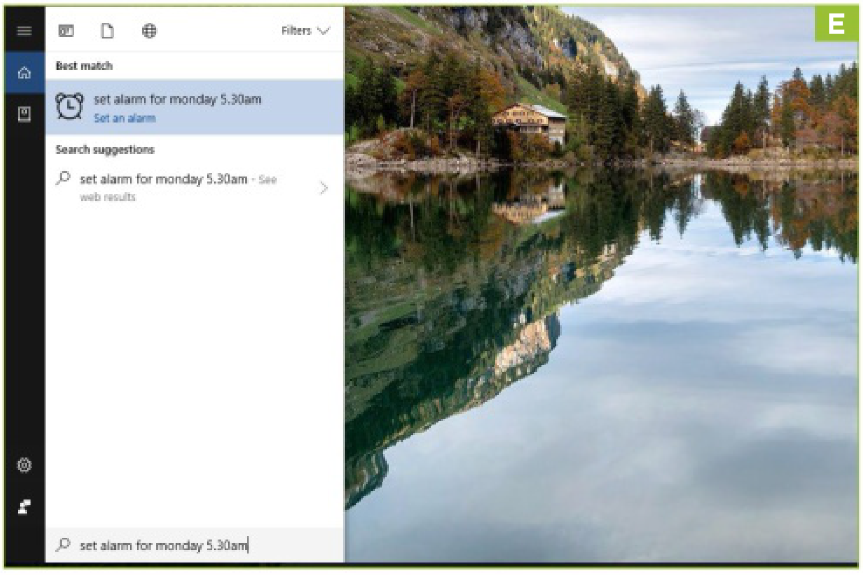

D
Filters
Best match
what's the weather in manchester
See web results
Search suggestions
what's the weather in manchester today - See web results
what's the weather in manchester tomorrow
what's the weather in manchester now
what's the weather in manchester on friday
what's the weather in manchester like
what's the weather in manchester on saturday
what's the weather in manchester in winter
All
Images
Videos
15:00
20:00
1:00
6:00
11:00
Wed 14
11°
7°
Thu 15
10°
6°
Fri 16
10°
2°
Sat 17
5°
-1°
Sun 18
3°
0°
Mon 19
5°
-1°
11°
10°
9°
7°
8°
See all web results

Manchester,
Updated 14 March, 13:20

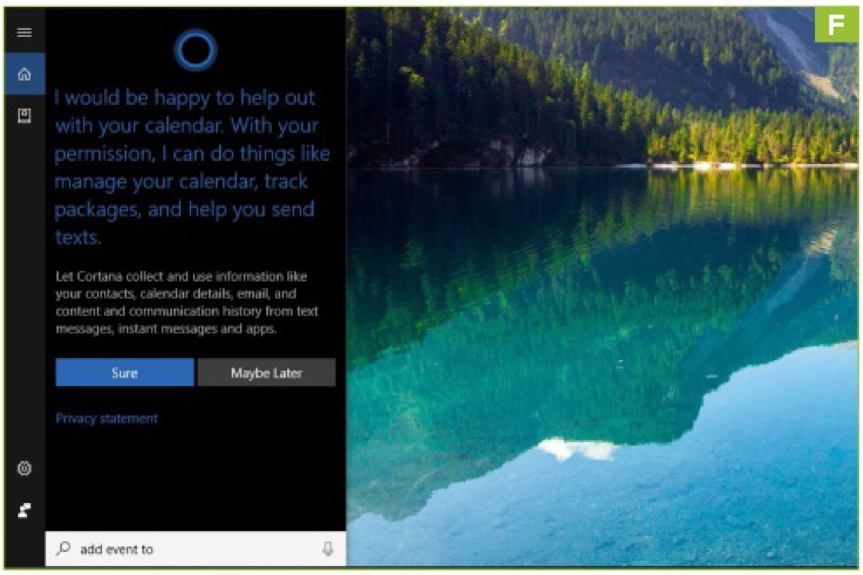
10 °C °F 11° Precipitation: 0%
7° Wind: 11 KMPH

Sunny · Wed 14, 14:16

what's the weather in manchester


E
Filters
Best match
set alarm for monday 5.30am
Set an alarm
Search suggestions
set alarm for monday 5.30am - See web results

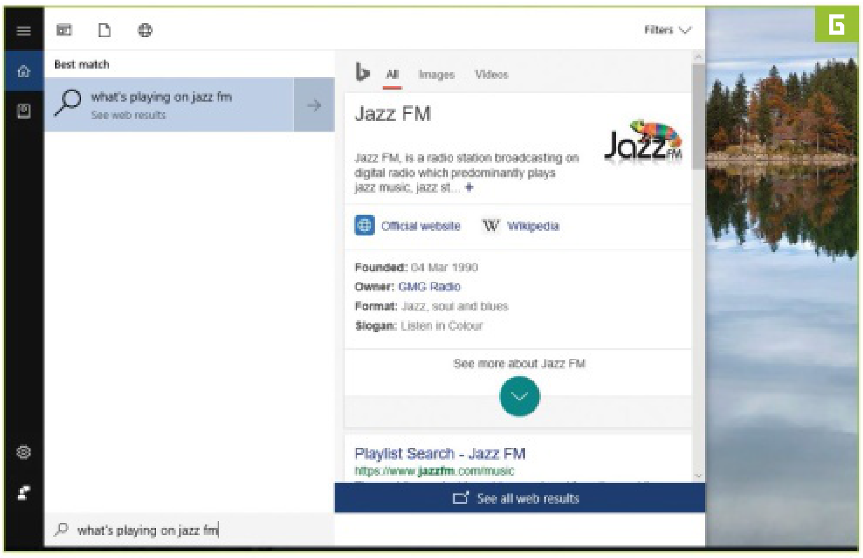
set alarm for monday 5.30am


F
Sure
Maybe Later
Privacy statement

I would be happy to help out with your calendar. With your permission, I can do things like manage your calendar, track packages, and help you send texts.

Let Cortana collect and use information like your contacts, calendar details, email, and content and communication history from text messages, instant messages and apps.

add event to


G
Filters
Best match
what's playing on jazz fm
See web results
All
Images
Videos
Jazz FM
Official website
Wikipedia
See more about Jazz FM
See all web results

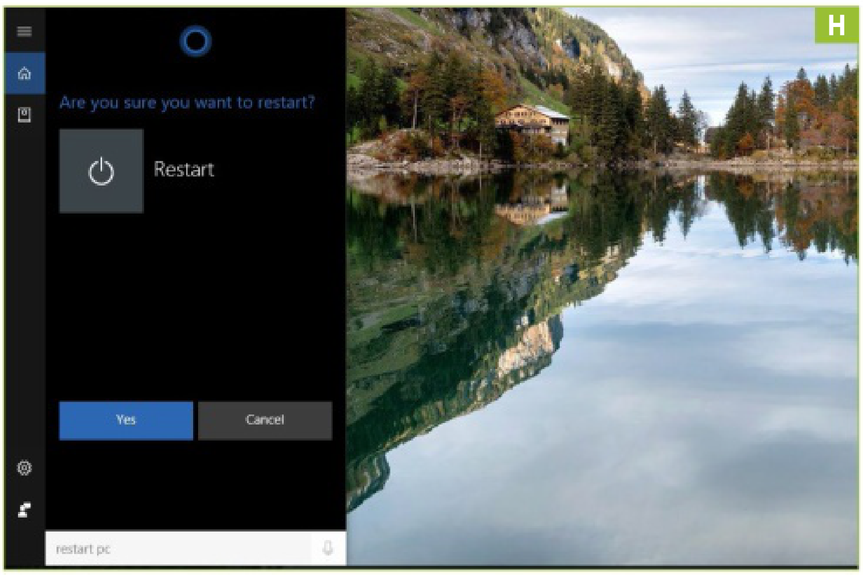
Jazz FM

Jazz FM, is a radio station broadcasting on digital radio which predominantly plays jazz music, jazz st... +

Founded: 04 Mar 1990
Owner: GMG Radio
Format: Jazz, soul and blues
Slogan: Listen in Colour

Playlist Search - Jazz FM
https://www.jazzfm.com/music

what's playing on jazz fm


H
Restart
Yes
Cancel

Are you sure you want to restart?

restart pc

© MICROSOFT

Test Your GPU Using Nvidia FrameView

YOU'LL NEED THIS

NVIDIA FRAMEVIEW
Download it from www.nvidia.com/en-us/geforce/technologies/frameview/.

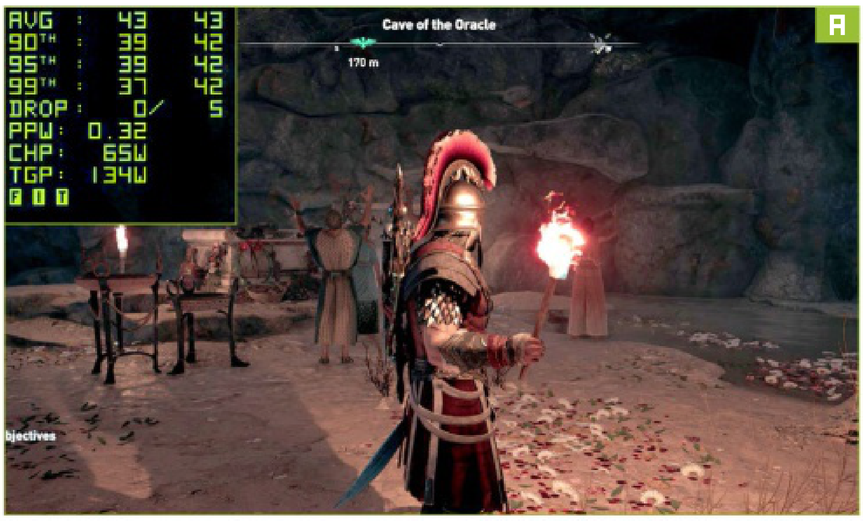
A COMPATIBLE GRAPHICS API
DirectX 9 or later, OpenGL, Vulkan, or Universal Windows Platform.

IT'S ALWAYS A GOOD IDEA to keep an eye on how your hardware is performing. Not only will this help you diagnose problems, but it can also indicate when it might be time to upgrade. If you're getting stuttering and frame drops during gameplay, for example, there's a good chance your graphics card may be past its prime.

There's a number of tools that you can use to ascertain the performance of your graphics card, from GPU-Z to HWiNFO, but none really provides a one-stop shop to help you measure power consumption, frame rates, performance-per-watt, and more. That's where Nvidia's FrameView comes in.

FrameView is a simple utility that provides a quick and easy way to see whether your graphics card is performing to its best. It works with almost every game, and supports DirectX 9 through 12, OpenGL, Vulkan, and Universal Windows Platform programs.

Note that, due to an apparent quirk in how AMD cards measure power draw, FrameView should not be used to compare the power consumption of Nvidia and AMD GPUs—see the boxout for more info. For everything else, though, it's a nifty little tool that can shed light on how your graphics card is chugging along—and whether it's time to replace it. –**ALEX BLAKE**



1 DOWNLOAD AND INSTALL

FrameView can be downloaded from Nvidia's website at www.nvidia.com/en-us/geforce/technologies/frameview/. Right now, it's still in beta, so be aware that you might encounter the odd bug here and there.

» Installing FrameView is super-easy. Unpack the ZIP file and navigate to the "FrameView_x64" folder. Here, right-click the "Install.cmd" file and click "Run as administrator." When it loads, press any key. It's important to run this file—without it, you won't get any power consumption results. Now, open the "FrameView_x64.exe" file located in the same folder to get started.

2 CAPTURE YOUR PERFORMANCE

Open FrameView and one of the first things you'll see is the benchmark folder location. You can change this to something that's easy to access; you can also change the benchmark hotkey, if you like.

» Next, head to the "Capture delay" section. Here you can define a delay between you pressing the benchmarking hotkey and the benchmark beginning, and also how long the benchmarking process should last. By default, both are set to zero seconds; for the capture duration, that means you have to manually stop the benchmark by pressing the hotkey again. Once the process has finished, the results are saved to a folder specified in the program, where you can analyze the results more closely.

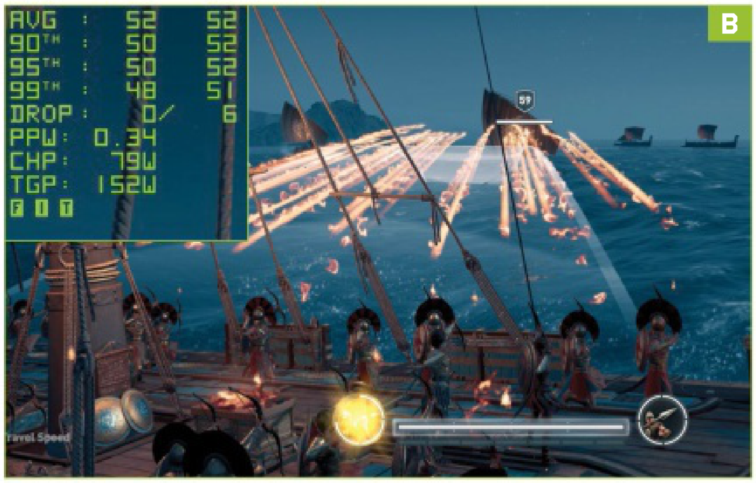
3 MEASURE POWER USAGE

FrameView measures power usage in a couple of ways. On the overlay, "CHP" indicates the power consumed by the chip on your graphics card. "TGP," on the other hand, is a measure of the total power consumed by both the chip and the rest of the graphics card's board (minus the power consumed by any device connected to the GPU's USB-C port, if it has one). For instance, our GPU is currently drawing 65W of power, while the total power used by the card is 134W [**Image A**].

» This data is used to calculate your graphics card's performance-per-watt (PPW) rating, which is determined by dividing your FPS by the TGP. Simply put, the larger this number is, the better your PPW rating, and the more efficient your graphics card is.

4 RENDERED FPS VS. DISPLAYED FPS

You can determine your graphics card's performance by measuring how much stutter you get in games. One way FrameView does this is by taking measurements for rendered FPS and displayed FPS. Rendered FPS is measured at the beginning of



© NVIDIA

the graphics "pipeline." It indicates "the smoothness of the animation delivered to the GPU," in Nvidia's words. Displayed FPS, in contrast, is what you actually see on screen in your game. If there's a noticeable difference between the two, it indicates the game is stuttering.

» If both rendered and displayed FPS are enabled in FrameView's settings, you'll see two columns of data on the in-game overlay. The left-hand column shows rendered FPS, while the right-hand column is for displayed FPS.

» Our readings for rendered and displayed FPS are very close [**Image B**], right through from the average FPS to the 99th percentile. This means that we're getting minimal stuttering.

5

UNDERSTANDING FPS PERCENTILES

FrameView enables you to record FPS for the 90th, 95th, and 99th percentiles. If your 99th percentile score is 70fps, for example, that means only one frame out of every 100 is below this rate. All three percentiles are useful, but the 99th percentile is the best indicator of your GPU's performance.

» Like rendered and displayed FPS scores, 99th percentile results can determine if you're suffering inconsistent frame rates under load. The closer your 99th percentile results are to your average frame rate, the less micro stutter you're getting. And if you're getting a lot of micro stutter and inconsistent frame rates, it might be time to upgrade your graphics card.

» As you can see [**Image C**], our average displayed FPS (the top row) is 64, while our 99th percentile displayed FPS rating is 62. This means that we suffered very little stuttering, as our performance hit 62fps or higher 99 percent of the time.

6

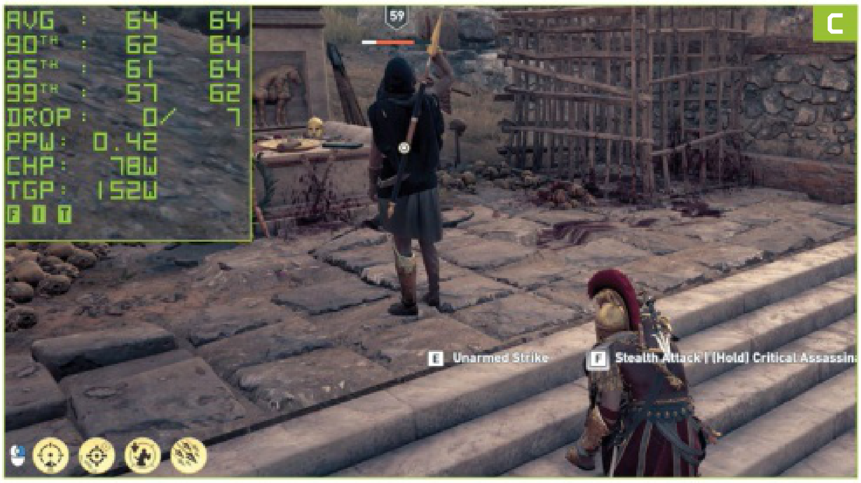
OVERLAY MODE TAGS

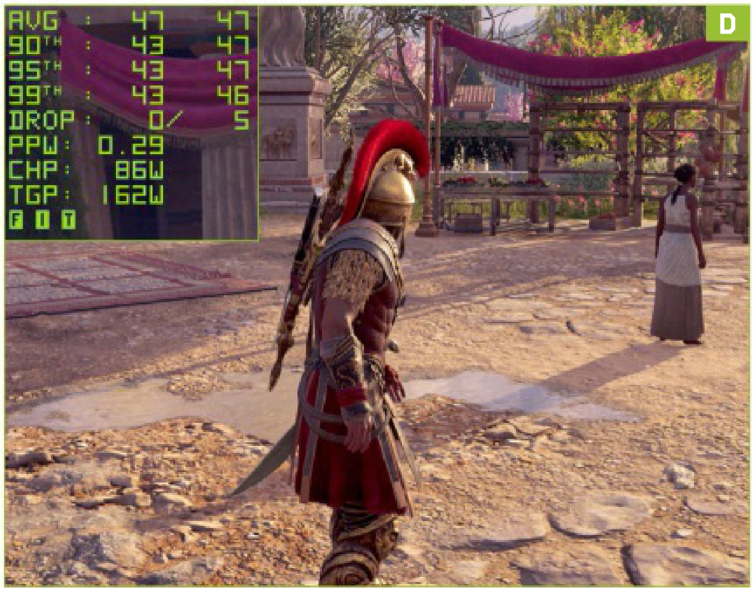
FrameView uses a few shorthand annotations to denote various things; these are known as the "overlay mode tags." At the bottom of the overlay, one or more of the following letters may be displayed: F, W, I, T, and V.

» "F" denotes that the game is running in full-screen mode. This is important, because it ensures the performance is properly measured at the resolution specified in-game. In contrast, "W" indicates that you're running the game in windowed mode. If you see "I," it means iFlip (or Independent Flip) mode is running, whereby the game is simulating Full Screen Exclusive mode.

» The other tags, "T" and "V," relate to VSync. "T" means "tearing" and indicates that VSync is disabled. This is better for performance analysis, because your frame rate isn't being tied to your monitor's refresh rate, but the upshot is you're more likely to experience screen tearing. If you see "V," that means VSync is enabled; if you want the most accurate testing results, it's best to disable this.

» For example, the tags "F," "I," and "T" are showing for us [**Image D**]. This means we're running the game in full-screen iFlip mode with VSync disabled.


```
AVG  :  64   64
90TH :  62   64
95TH :  61   64
99TH :  57   62
DROP :  0/    7
PPW  : 0.42
CHP  :  78W
TGP  : 152W
F I T
```


```
AVG  :  47   47
90TH :  43   47
95TH :  43   47
99TH :  43   46
DROP :  0/    5
PPW  : 0.29
CHP  :  86W
TGP  : 162W
F I T
```

7

ANALYZING YOUR RESULTS

When you finish benchmarking, FrameView saves the results in two spreadsheets, each with the game name and timestamp in the file name. The information here can seem overwhelming, but there are a few key things to pick out.

» The "Scan_Log" file is fairly straightforward, giving a quick overview of things such as the average number of frames rendered ("RenderAvg"), the 99th percentile of frames displayed ("Display99"), and more.

» The "Scan_Report" file is more complicated, showing data in millisecond intervals. The key things here to look out for are the "MsBetweenPresents" and "MsBetweenDisplayChangeActual" columns, which represent rendered FPS and displayed FPS respectively.

» The "Scan_Report" file is also useful because it can help you chart power draw and performance-per-watt data over time. If you see sudden drops or spikes in these numbers, you may have a problem.

MEASURING AMD PERFORMANCE

If you have an AMD graphics card, you'll notice that FrameView's overlay has a reading for "AMDPWR" instead of performance-per-watt, chip power, and total power consumption. What does this mean for you?

Nvidia says that AMD's power consumption API only gives a value for something between chip power and total power, rather than separate readings for each. Without knowing the GPU's total power consumption, FrameView can't calculate your performance-per-watt (PPW) rating, because you work out PPW by dividing your FPS by total power consumed.

In practice, this probably won't affect you too much—you may find FrameView's FPS readings more useful, and the program accurately reports those for AMD cards. But if you really want to dive into your card's power consumption readings, it's less than ideal.

Ultimately, this would require AMD changing how its API works in order to give separate readings for chip power and total board power. You therefore shouldn't use FrameView to compare power consumption between Nvidia and AMD graphics cards, due to its inaccuracies measuring the power used by the latter.

Get the Most from Your AMD CPU

YOU'LL NEED THIS

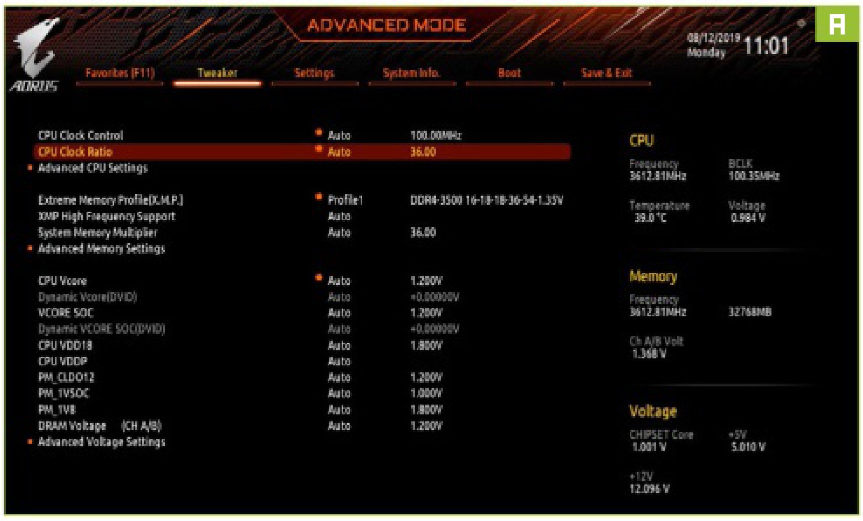
AMD RYZEN CPU
Your system should have a Ryzen CPU, ideally a 2000-series or better.

AMD RYZEN MASTER SOFTWARE
This can be downloaded from www.amd.com.

OVERCLOCKING IS A FINICKY BUSINESS: Adjusting frequencies and voltages to try to eke out a bit of extra performance from your rig—while simultaneously avoiding the terror of the blue screen of death. It's often a lengthy process, too, demanding repeated trips into your BIOS to make minuscule adjustments. AMD processors are also known to be a little tougher to effectively overclock than Intel's K-variant chips, which have excellent overclocking headroom.

Thankfully, there's an easier way to manage overclocking on AMD processors. While there is plenty of licensed and unlicensed overclocking software out there, AMD has its own official piece: Ryzen Master, which can adjust both CPU and RAM settings on the fly in Windows. No BIOS trips necessary.

Ryzen Master isn't necessarily the easiest piece of software to use, mind you. The overclocking system is fundamentally the same as overclocking in the motherboard BIOS, insofar as it involves raising the operating frequency of the CPU, then raising the voltage supplied to the motherboard socket in order to prevent crashes. However, the Ryzen Master interface is mercifully much easier to navigate than most BIOSes, and it comes equipped with a few other nifty features that make overclocking a breeze, even for those without the usual tech mastery required. **–CHRISTIAN GUYTON**



```
CPU Clock Control                      Auto      100.00MHz
CPU Clock Ratio                        Auto      36.00
Advanced CPU Settings

Extreme Memory Profile(X.M.P.)         Profile1  DDR4-3500 16-18-18-36-54-1.35V
XMP High Frequency Support             Auto
System Memory Multiplier               Auto      36.00
Advanced Memory Settings

CPU Vcore                              Auto      1.200V
Dynamic Vcore(DVID)                    Auto      +0.00000V
VCORE SOC                              Auto      1.200V
Dynamic VCORE SOC(DVID)                Auto      +0.00000V
CPU VDD18                              Auto      1.800V
CPU VDDP                               Auto
PM_CLDO12                              Auto      1.200V
PM_1VSOC                               Auto      1.000V
PM_1V8                                 Auto      1.800V
DRAM Voltage     (CH A/B)              Auto      1.200V
Advanced Voltage Settings

CPU
Frequency        BCLK
3612.81MHz       100.35MHz
Temperature      Voltage
39.0 °C          0.984 V

Memory
Frequency
3612.81MHz       32768MB
Ch A/B Volt
1.368 V

Voltage
CHIPSET Core     +5V
1.001 V          5.010 V
+12V
12.096 V
```

1 GET PREPPED

First, you need to get set up. Before doing anything, take a trip to Google and find out the actual overclocking headroom on your CPU. Overclocking is best done gradually, but it's good to know what the effective maximum clock you're likely to reach is, so you don't push too far too early, and risk damaging your processor. It's also worth checking purely because there's a chance that your CPU isn't actually up to much when it comes to overclocking—lower-end chips can have very minimal potential for it, and sometimes it's best to just stick to automatic overclocks. We'll get to that later, though.

›› You're also going to want a fairly robust cooling solution. That means no stock air coolers, although AMD's Wraith Max may cover you for some tinkering. Ideally, we recommend an all-in-one cooler with a 240mm radiator—or larger, if you're using a custom liquid-cooling loop to cool multiple parts. Once your system is ready, download and install the Ryzen Master software from the AMD website, and fire it up [**Image A**]. It's time to get started.

2 RUNNING ON AUTOPILOT

Upon booting up Ryzen Master, you're greeted with the homescreen. This displays live data from your CPU, including the current operating frequencies of each individual core, the power draws, and the temperature. The first step here is to choose a profile that you're going to work in. Ryzen Master comes with two preset profiles, called "Creator Mode" and "Game Mode," then two blank profiles for you to name yourself. All four actually have the same initial settings, but for now select "Profile 1."

›› Check out the annotated diagram to make sure you're on the right page. From here, there's a few different options. If you like the easy life, you can hit the "Auto Overclocking" option at the top of the screen, then select "Apply and Test." Ryzen Master has its own benchmarking test, which it can run after applying new settings to stress-test the CPU. However, we've found that this test isn't too rigorous—hardcore benchmarks such as Prime95 and AIDA64 put the processor under heavier strain, and in our testing, the CPU would reguarly pass the Ryzen Master stress test before crashing within two seconds of Prime95's operation.

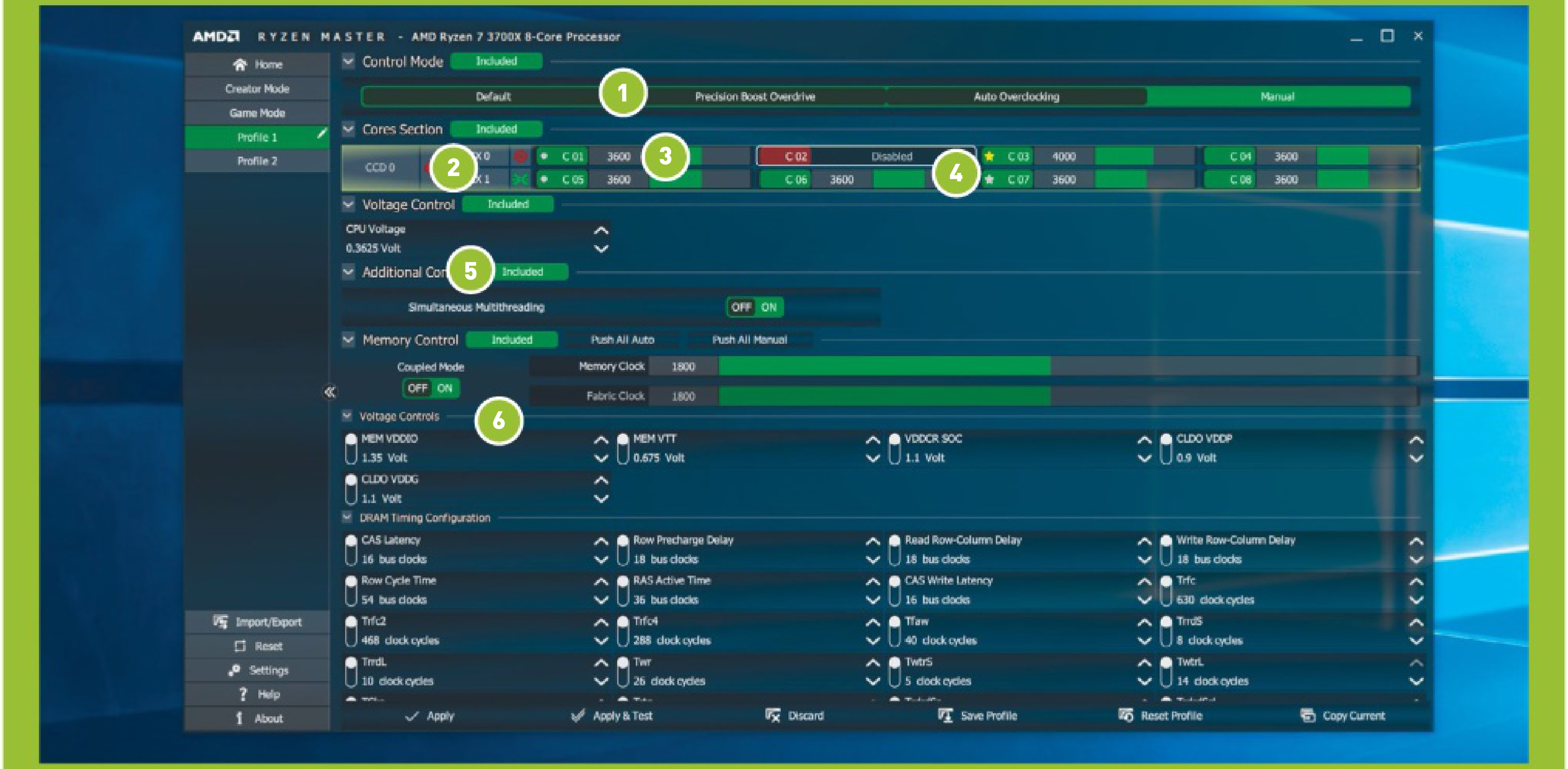
›› With the auto overclocking mode, you have a couple of settings to tweak. Power supply options can be changed at the top of the interface, although the only setting we really recommend changing is '"Boost Override CPU." This should default to 100, but if you're not seeing the performance you want after engaging auto overclocking, try turning it up by increments of 25. The other potential option here is the "Precision Boost Overdrive," originally created by AMD for Threadripper processors. This supposedly redistributes power with even greater precision, as required by individual system components and CPU cores, but ultimately doesn't produce much of a difference in performance from the auto overclocking mode.

3 CLOCKED IN

If you're up for a bit more of a challenge, though, there's the manual mode. If you're familiar with CPU overclocking via the BIOS, this stage should be

© WINDOWS, AMD

A QUICK GUIDE TO THE RYZEN MASTER UI



Control Mode Included
Default | Precision Boost Overdrive | Auto Overclocking | Manual

Cores Section Included
CCD 0
C 01 3600
C 05 3600
C 02 Disabled
C 06 3600
C 03 4000
C 07 3600
C 04 3600
C 08 3600

Voltage Control Included
CPU Voltage 0.3625 Volt

Additional Control Included
Simultaneous Multithreading OFF ON

Memory Control Included
Coupled Mode OFF ON
Memory Clock 1800
Fabric Clock 1800

Voltage Controls
MEM VDDIO 1.35 Volt
MEM VTT 0.675 Volt
VDDCR SOC 1.1 Volt
CLDO VDDP 0.9 Volt
CLDO VDDG 1.1 Volt

DRAM Timing Configuration
CAS Latency 16 bus clocks
Row Precharge Delay 18 bus clocks
Read Row-Column Delay 18 bus clocks
Write Row-Column Delay 18 bus clocks
Row Cycle Time 54 bus clocks
RAS Active Time 36 bus clocks
CAS Write Latency 16 bus clocks
Trfc 630 clock cycles
Trfc2 468 clock cycles
Trfc4 288 clock cycles
Tfaw 40 clock cycles
TrrdS 8 clock cycles
TrrdL 10 clock cycles
Twr 26 clock cycles
TwtrS 5 clock cycles
TwtrL 14 clock cycles

1. CHOOSE YOUR MODE
You can select between modes here. All profiles are set to "default" at first; no overclocking whatsoever.

2. MAKE THE LINK
These icons indicate whether each CCD and CCX (core groups) are linked. Green is linked, red is unlinked. Linked cores match each others' frequency.

3. FIDDLE WITH THE FREQUENCY
This is the operating frequency of each core, adjustable by the green bar. Cores can be disabled by clicking the green box, but we wouldn't recommend this.

4. SPEED STARS
This icon represents which core is the fastest: Yellow stars denote the fastest core; gray is the fastest within that CCX.

5. AMP UP THE VOLTAGE
Voltage control should always be left included. Tweak it upward in small increments using the arrows.

6. FORGET THE MEMORY
Memory control is excluded, and set to auto by default, and unless you know what you're doing, it's best to leave it that way.

pretty straightforward. Don't worry if you're not, though; we're going to give you the full rundown. Start by selecting manual mode, then make sure that all the cores are linked by clicking the icon on the right-hand side, so that all the cores are green. (Check our annotation above if you're not sure which icon we're talking about.) From there, you can either click and drag the green slider bars to adjust the operating frequency, or click the number and type it in directly.

›› Generally, it's best to raise the frequency in increments of 0.1GHz between tests. If you know the maximum boost clock of your processor, though, it's a safe bet to start by stepping up the frequency by half the difference between the base and boost clocks. So, if your processor has a base clock of 3.7GHz and a boost clock of 4.3GHz, you can cut out some of the testing and go straight to 4.0GHz without too much concern of damaging your processor. Once your chosen frequency is set, hit "Apply and Test." This may require a restart—allow the system to reboot, and Ryzen Master will begin automatically after a few moments. As we mentioned earlier, it's best to run a more demanding program than the Ryzen Master stress test, just to make sure that the system will run. Chances are, you'll experience a crash here; don't worry—that just means that you'll need to raise the voltage being supplied to the CPU. Do this in Ryzen Master, first by 0.2V and then by 0.1V at a time, until the system can withstand a sustained stress test at your overclocked frequency without crashing.

4 STABILIZING

Once you've got a stable overclock, keep stepping it up by increments of 0.1GHz. When your system crashes under stress, raise the voltage by a small amount, then continue. Ryzen Master insists on auto-adjusting the voltage to more precise amounts, but don't worry about this. Eventually, you will reach a stage where operating the system under stress becomes impossible, regardless of the voltage increase. At this point, dial the frequency back by 0.1GHz, and find the lowest voltage at which the system can be successfully stress-tested at—that's your stable overclock. All done!

›› Of course, there are more precise ways to overclock. Your CPU—particularly one of the higher-end 3000-series Ryzen chips—will demonstrate that certain cores operate at better speeds than others. Ryzen Master highlights the faster cores, so if you're struggling to get a functioning overclock, focusing on individual cores can potentially solve your issues. To do this, unlink the cores so that all the icons are red, then clock up the fastest cores, and raise the voltage where needed. The performance difference may not be as noticeable, but these faster cores can potentially be clocked higher than the overall maximum attainable clock speed for the CPU using all cores, which results in superior performance in tasks that only use a single core. ⏻

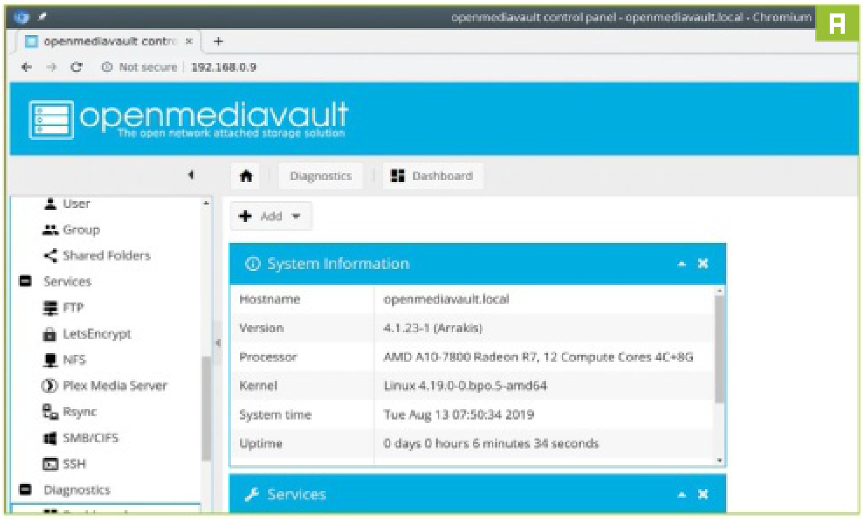
Use OpenMediaVault to Run Your NAS

YOU'LL NEED THIS

OPENMEDIAVAULT
Download the latest ISO from www.openmediavault.org/download.html.

IN OUR AUGUST ISSUE, we built a mini NAS box using mostly scavenged parts. We also skimmed over setting up Volker Theile's OpenMediaVault (OMV), a Debian-based Linux distro that takes the pain out of configuring and maintaining such things. For the "Build It" feature, we didn't cover this software side of things in much depth, so in these two pages, we'll try to remedy that.

Naturally, we assume you already have suitable hardware—basically any PC, but ideally something with one or more large drives in it. We'll cover setting up a RAID array, which will cover you in case one (or more if you opt for extra redundancy) of your drives fail. Remember, RAID doesn't protect against fat-fingered deletions, or even subtle drive failures (where data is silently corrupted or incorrectly read). The only salve there is regular backups. Fortunately, these can be managed by OMV, too, and plugins can handle encrypting them and sending them off site to cloud storage services. If you're brave enough to make your NAS visible to the outside world (not a decision you should take lightly, by the way), OMV also can also handle firewalling via IPTables. **–JONNY BIDWELL**



Hostname	openmediavault.local
Version	4.1.23-1 (Arrakis)
Processor	AMD A10-7800 Radeon R7, 12 Compute Cores 4C+8G
Kernel	Linux 4.19.0-0.bpo.5-amd64
System time	Tue Aug 13 07:50:34 2019
Uptime	0 days 0 hours 6 minutes 34 seconds

1 INSTALL OMV

Fetch the latest OMV ISO from www.openmediavault.org/download.html, and write it to a USB stick using a tool such as Etcher (available for Windows, Linux, and macOS at https://etcher.io). Reboot and try to convince your firmware to boot this freshly etched medium. You need to disable secure boot, because Debian Linux (upon which OMV is based) doesn't believe in it. Also, before we go any further, be aware that the target drive will be totally wiped. There's no provision for installing alongside other partitions, so using a large drive for OMV itself is a bit of a waste (it only requires around half a gig). Any spare large storage you have should be summoned for duty in your NAS box forthwith.

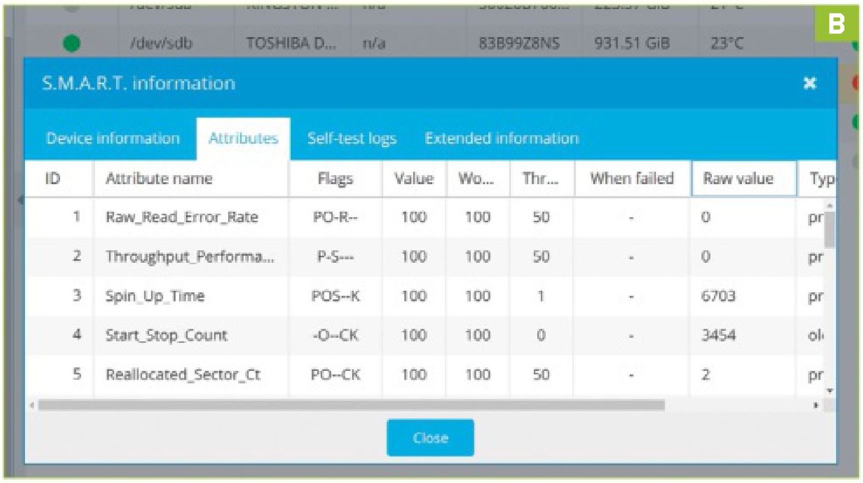
›› The installer is a spartan text-based affair, but is pretty straightforward. Just follow the prompts and you're guided through localization and hostname setting. You're prompted for a root password (which you may end up only using once, or never, but don't forget it), then asked to choose a local mirror (for updates), and specify a proxy (if required). Finally, the bootloader is installed and you should be able to reboot into OMV.

2 SET PASSWORD

Hopefully, OMV will boot up without error, and tell you to visit the web control panel. Below this message you should find your NAS's IP address displayed. If it's not (this sometimes happens if DHCP takes too long), log in as root, and type "ip a". On another machine on your network, visit this address in a web browser and log in with the username "admin" and password "openmediavault." The root password you set earlier is only used for console logins, which you'll probably only need if something breaks. Until then, behold the wonderful OMV interface [**Image A**]. From here, you can set up in a few clicks what would take hours of fiddling with awkward command-line syntax and text editors that can't be readily egressed in a regular Linux distribution. The first thing you should do is change the default password, though, even if you trust the people using your network. It would be terrible if some malware were able to hose all your data just because it knew the default password. You'll find this option in "General Settings → Web Administrator Password." If you choose to make your NAS accessible from the whole Internet, a strong password is essential.

3 LOOK SMART

Modern hard drives are smart things. So smart, they monitor their own health and keep track of all kinds of vital signs. Anomalies in these SMART (Self-Monitoring, Analysis, and Reporting Technology) attributes can be a sign of impending drive failure, so if you keep an eye on them, you might just buy yourself enough time to rehouse your data (or replace the failed drive if it's part of an array), before it vanishes in a puff of



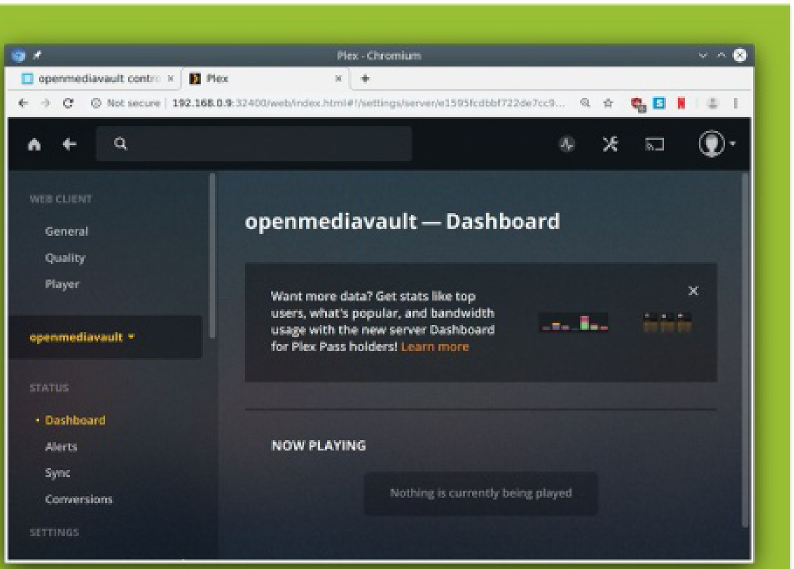
ID	Attribute name	Flags	Value	Wo...	Thr...	When failed	Raw value	Typ
1	Raw_Read_Error_Rate	PO-R--	100	100	50	-	0	pr
2	Throughput_Performa...	P-S---	100	100	50	-	0	pr
3	Spin_Up_Time	POS--K	100	100	1	-	6703	pr
4	Start_Stop_Count	-O--CK	100	100	0	-	3454	ol
5	Reallocated_Sector_Ct	PO--CK	100	100	50	-	2	pr

© OPENMEDIAVAULT

SNUG AS A PLUGIN A RUG

OpenMediaVault is very extensible, and a number of plugins are available from "System → Plugins." The USB backup tool is pretty handy for automatically backing up folders (such as your very important documents or photos) to a USB drive. There are also plugins for the Transmission BitTorrent client or encrypted storage via LUKS. A number of more adventurous third-party plugins are available from the OMV-Extras repository. To enable this, go to http://omv-extras.org/joomla/index.php/guides, download the .deb file for OMV 4.x, and follow the rest of the instructions on that page. The list of available plugins multiplies, giving access to (among others) the SnapRAID and MergerFS plugins for more flexible storage—conventional RAID can lead to wasted space on differently sized drives.

You'll find a new "OMV-Extras" menu entry for adding more repositories, including Docker, TeamViewer, and Plex, which can index your media library (as long as it's vaguely organized), and turn your NAS into a complete media streaming solution. It can send video to any device with a web browser and transcode video on the fly. Once you've enabled the repo and updated, the Plexmediaserver plugin can be found in the list.


Plex - Chromium
openmediavault contr
Plex
Not secure | 192.168.0.9:32400/web/index.html#!/settings/server/e1595fcdbbf722de7cc9...
WEB CLIENT
General
Quality
Player
openmediavault
STATUS
Dashboard
Alerts
Sync
Conversions
SETTINGS
openmediavault — Dashboard
NOW PLAYING

Want more data? Get stats like top users, what's popular, and bandwidth usage with the new server Dashboard for Plex Pass holders! Learn more

Nothing is currently being played

unreadable sectors. From the menu on the left, go to "Settings → S.M.A.R.T." and hit the "Enable" switch. In the "Devices" tab, activate SMART for each of your storage drives, and optionally for the OS drive as well. Drives slyly keep a few sectors spare, so that unreadable ones can be reallocated, and this reallocated sector count is one of the myriad attributes which OMV is now diligently watching over. Should this become non-zero, or any other drive health stat become concerning, you'll see a red circle in the status column, and you can investigate further with the "Information" button [**Image B**]. Often these alerts are isolated incidents and nothing to worry about, but if the bad numbers start to increase frequently, swift action is required.

4

RAID-ON

Now go to "Storage → Disks," and select one of the drives you're going to use as new storage (not the one we just installed OMV on, or a drive that's already got data on it). Drives need to have their partition tables nixed before they can be safely used in RAID arrays, so hit the "Wipe" button, and repeat this for other new storage drives. Non-empty drives can't readily be enrolled in RAID arrays, but if you have the spare space, you can copy the data to the new array, wipe the old drive, then grow the array to include it. Go to "Storage → RAID Management," and click the "Create" button. OMV can handle anything from mirroring two or more drives (RAID 1) to dual parity across four or more drives (RAID 6), and several configurations beyond and in between those. Striping (RAID 0) doesn't make much sense on a NAS box, because network bandwidth is likely the limiting factor. Give your array a name. Choose a RAID level apropos to the number of drives you have and the amount of redundancy you require or desire. We had three inexpensive 1TB disks, so we made a RAID 5 array.

5

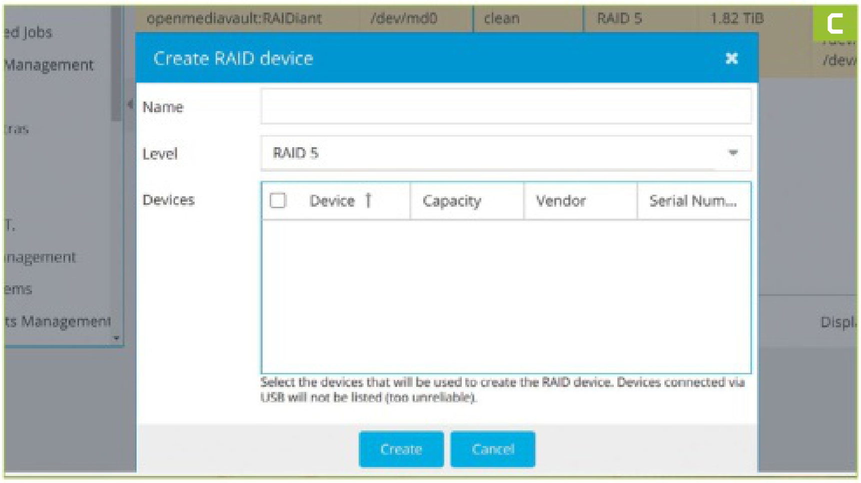
FILESYSTEM FUN

Creating the array takes a long time if you use RAID 5 or 6 (ours took about 10 hours), but you can start using it right away, albeit in degraded mode, while the parity structures are initialized. Before you can copy any data, though, you need to bestow a filesystem upon the array. Head to "Storage → Filesystems," and click "Create" [**Image C**]. Select the RAID device, probably labeled "/dev/md0," and choose a filesystem. Unless you have reason to suspect otherwise, Ext4 is a good choice. Now go to "Access Rights Management → Shared Folders," and create some folders.

6

DO THE SAMBA

There are multitudes of ways you can share these shared folders, but the most common is using Samba, which makes your shares visible via Windows Networking. Set up a user from the "Access Rights Management → Users" page, so that a password is required to see shares. Go to "Services → SMB/CIFS." In the "Settings" tab, you can configure cosmetic details such as the workgroup name, and in the "Shares" tab you can add your shared folder and make it "Public" or "Read Only." For more fine-grained access controls, go back to the "Shared Folders" settings [**Image D**]. ⏻


C
ed Jobs
Management
ras
T.
nagement
ems
ts Management
Displ
/dev
Device
Capacity
Vendor
Serial Num...
Create
Cancel

openmediavault:RAIDiant /dev/md0 clean RAID 5 1.82 TiB

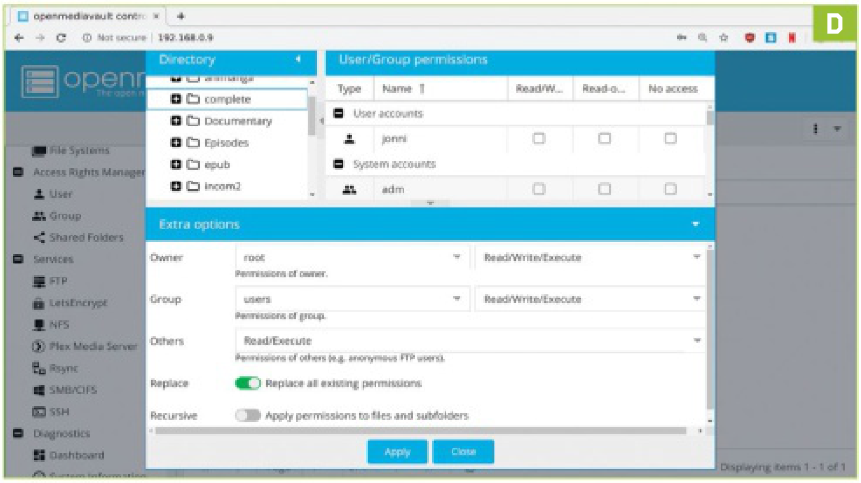
Create RAID device

Name:

Level: RAID 5

Devices: ☐

Select the devices that will be used to create the RAID device. Devices connected via USB will not be listed (too unreliable).


D
openmediavault contr
Not secure | 192.168.0.9
openm
File Systems
Access Rights Manager
User
Group
Shared Folders
Services
FTP
LetsEncrypt
NFS
Plex Media Server
Rsync
SMB/CIFS
SSH
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incom2
User/Group permissions
Type
Name
Read/W...
Read-o...
No access
User accounts
System accounts
Extra options
Apply
Close
Displaying items 1 - 1 of 1

Name	Read/W...	Read-o...	No access
jonni	☐	☐	☐
adm	☐	☐	☐

Owner: root — Read/Write/Execute
Permissions of owner.

Group: users — Read/Write/Execute
Permissions of group.

Others: Read/Execute
Permissions of others (e.g. anonymous FTP users).

Replace: ● Replace all existing permissions

Recursive: ○ Apply permissions to files and subfolders

Work with Images in Affinity Publisher

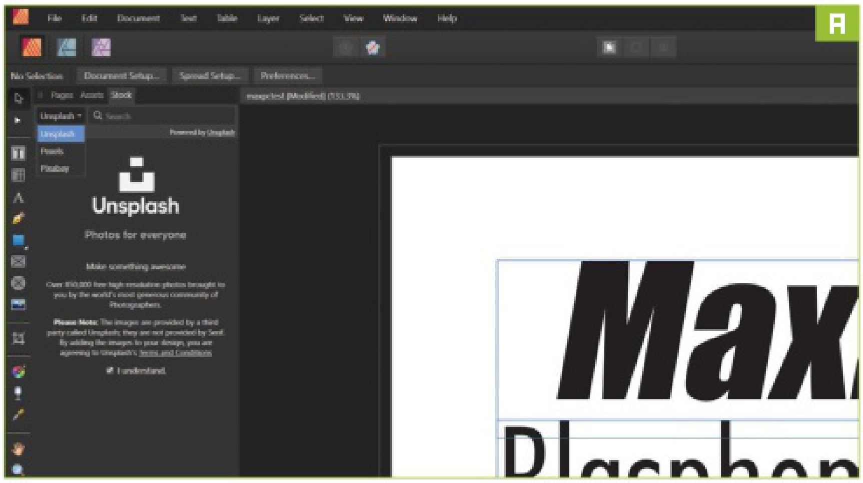
YOU'LL NEED THIS

SERIF AFFINITY APPS, Buy the full set of apps or download their free trials from http://affinity.serif.com.

SERIF'S BATTLE AGAINST ADOBE has seen its third great push forward, with the launch of Affinity Publisher earlier this summer. While it might not be troubling InDesign CC as the page layout tool of choice just yet (although Adobe toppled Quark, so it does happen), it comes with a host of highly attractive features, and doesn't require a monthly subscription.

The Affinity name has puzzled some since the series appeared, with Illustrator rival Affinity Designer on Mac, in 2014. Publisher makes it clear what it means—the three apps (Photoshop-a-like Affinity Photo completes the trinity) come together in the top-left corner of Publisher. Select an image and click the "Photo" button, and you're able to edit it within Publisher using all the tools found in Photo. The same goes for a vector illustration and Designer—as long as you own all the apps, of course.

So, with a full set of apps installed, and updated to version 1.7, here's our guide to the new kids on the publishing block. Free trials of the apps are available from http://affinity.serif.com if you want to try them out for yourself. **–IAN EVENDEN**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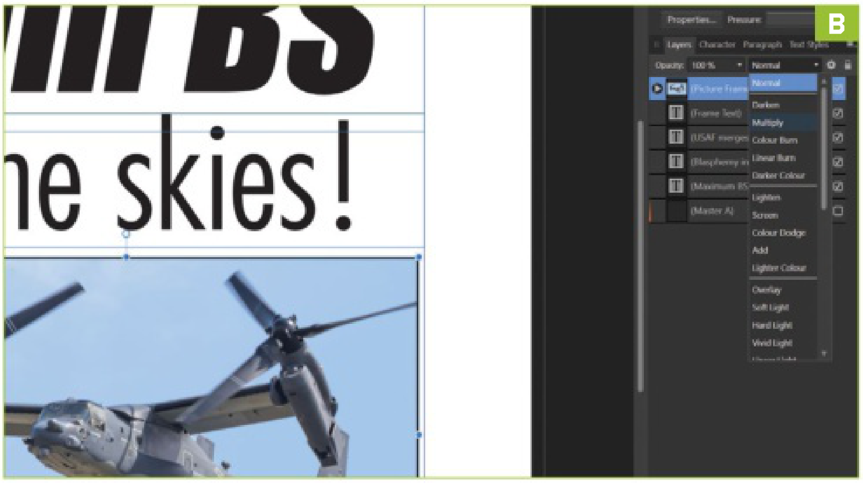
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Soft Light
Hard Light
Vivid Light

1 IMPORT IMAGES

If you want to edit images within a page layout app, you need to get them there. Affinity Publisher has a standard "Place" command, from the "File" menu, or a Place Image tool in the bottom of the toolbar. Better than these, however, is the Picture Frame tool, which opens a Properties palette that's missing if you "Place" an image. From Properties, you can fit an image to the frame in various ways, and stroke the edge of the frame to create a hard border between it and the rest of the document.

2 FIND IMAGES

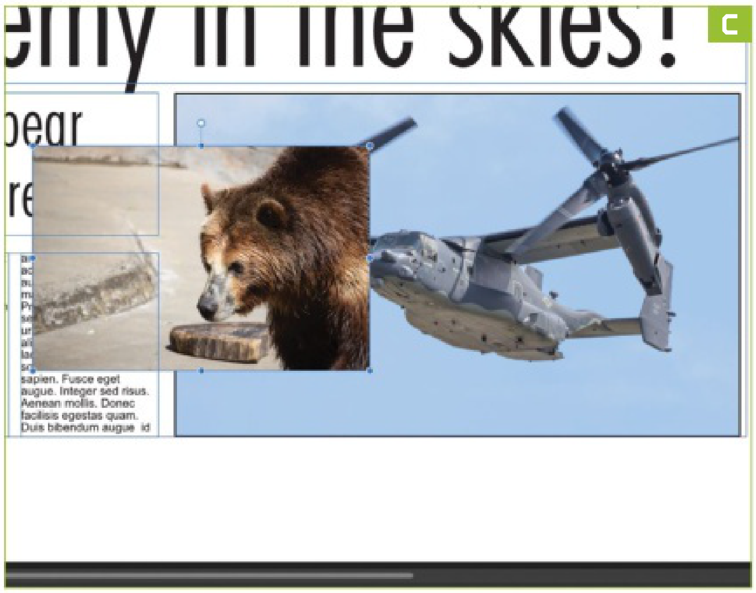
You can, of course, import images directly from your PC, but there are other ways to lay your hands on images. Serif has done deals with Unsplash, Pexels, and Pixabay to bring their imagery directly into Publisher through a Stock palette that appears on the left-hand side whenever you've got a picture frame selected [**Image A**]. Agree to the terms and conditions of your favored library, and you can search it for images that suit the publication you're working on.

3 IMPORT IMAGE

The easiest way to import an image from your PC is to select an empty picture frame, or draw one, then hit "Replace Image" at the top-left. An Explorer window appears, and you can choose your image as you would in any other app. When it's loaded into the frame, you can drag it around and rotate it with the tools that appear within the frame while your mouse is over it. A slider also appears below the frame that controls the zoom level. From the Properties palette, you can choose various methods of auto-fitting, too.

4 LAYERS

Each object in Affinity Publisher exists on its own layer. The Layers palette acts in exactly the same way it does in Adobe apps, except the control to show and hide layers is a checkbox rather than an eye, and it resides on the other side of the palette [**Image B**]. Otherwise, you



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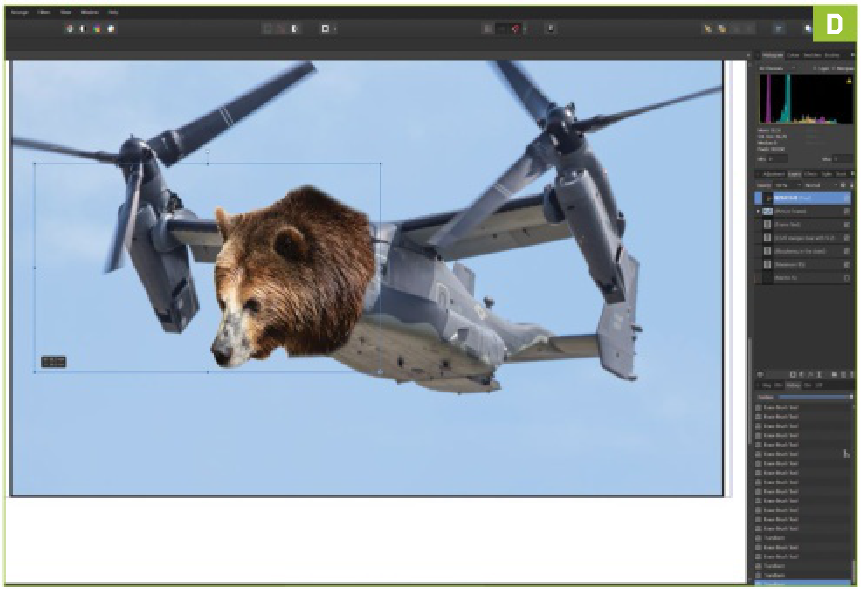

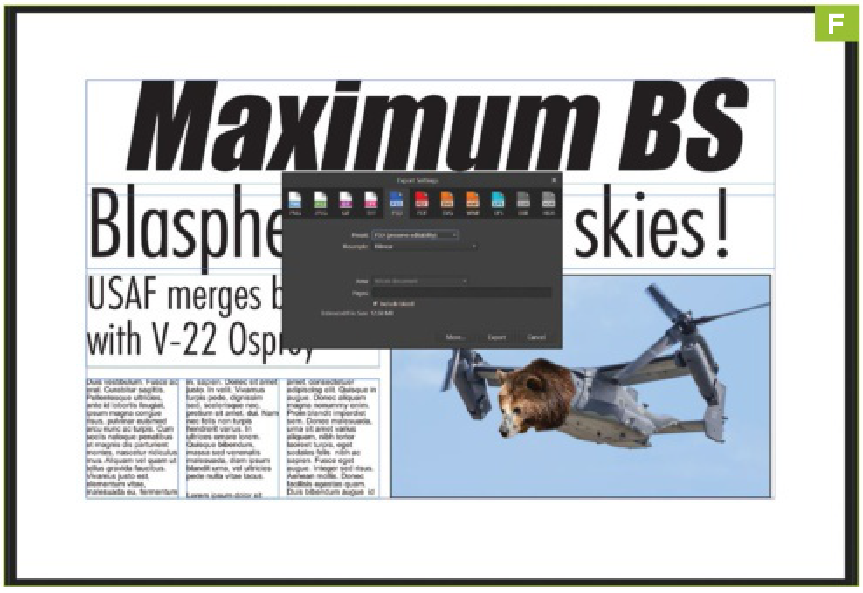
F
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Blasphe
skies!
USAF merges b
with V-22 Ospr

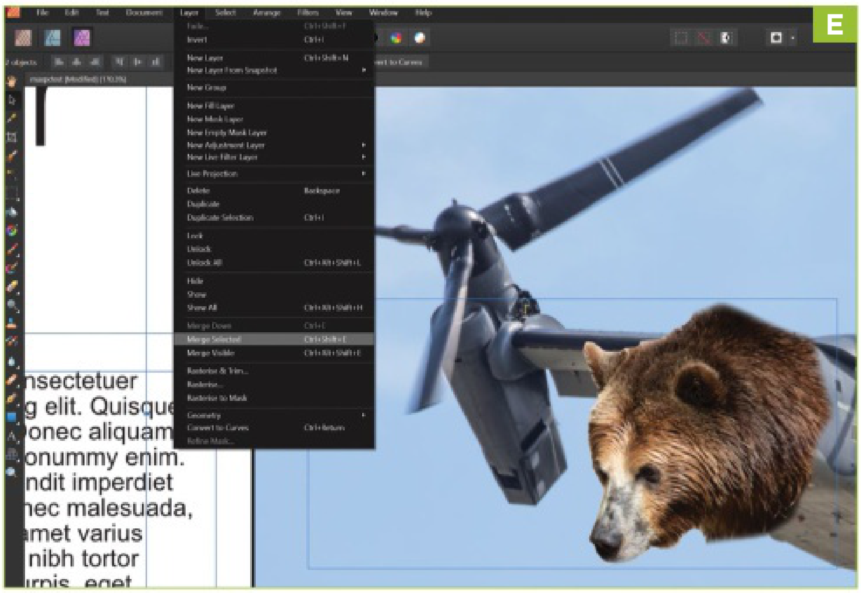
can blend, stack, and fade layers just as you would in Photoshop. Or, indeed, InDesign.

5 EDIT PHOTOS WITHIN PUBLISHER

We've got an extraordinary claim as the headline of our news-sheet here, so we'd better serve up some extraordinary evidence. We use the Place Image tool to import our bear, ending up with a loaded cursor we can drag out into a frame any size we want, or hold over an existing frame to populate it with a click [**Image C**]. To open your document in the Photo app outside Publisher, choose "File → Edit in Photo"—all your layers transfer across intact. However, we're going to do our editing in Publisher's Photo Persona, switching to it using the button at the top-left of the interface.

6 PHOTO PERSONA

Changing Persona changes all the tools. So, instead of tools for drawing frames and handling text, we now have the familiar brushes, buckets, stamps, and erasers of an image-editing app [**Image D**]. We're going to choose the Eraser, and brush away most of the bear image, so that just his (could be a her, we didn't ask) head remains, ready to be composited over the cockpit of the Air Force's finest tiltrotor aircraft. Image frames can have backgrounds, set using a color wheel, but placed images such as this are transparent once you begin wiping them away. The brush previews what you'll see before you commit to it, so you can check if you're brushing down to the layer below or a background color. Holding Ctrl and rolling the mouse wheel zooms in and out to the pointer's position, so you can change the view to a more precise one. After all, fakery at this level of sophistication needs to be really good, or it will fool no one. The History palette works in its usual way whatever Persona you're in, so you can always go back and try bits again.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7 MOVE AND ROTATE

Just like in other image-editing apps, Publisher's Photo Persona enables you to resize, move, and rotate the layer using frag handles arranged around the edge of the frame. Affinity's main difference is that rotation is achieved using a handle that sticks up slightly from the frame. A placed image like this is distorted if you move the edges, whereas one in a frame isn't, as you are moving the frame. So, be careful to use the corner handles if you want it to remain in its original ratio.

8 MERGE LAYERS

The bear and the Osprey are pretty realistically merged, but still separate as far as Publisher is concerned. Merge them by Ctrl-clicking to select the two layers (the images, not the frame) in the Layers palette, then choosing "Layer → Merge Selected" [**Image E**].

9 SAVE AS…

The .afpub files produced by Affinity Publisher can be opened in the Photo and Designer sister apps, but Windows has a nasty habit of associating them with the last app you used to open one in, so you might not always get Publisher if you double-click one. Export options include PDF, JPEG, PNG, EPS, and Adobe's PSD format (with layers), so you should always be able to transfer something you've created to a non-Affinity app, as long as you don't want to edit it there [**Image F**]. ⏻

PERSONAS

The idea of Personas is not new to the Affinity series. Affinity Photo uses it to switch between raw image development, photo editing, HDR creation, and image liquification, while Affinity Designer can swap between vector and raster editing. They both have a dedicated Persona for exporting images. It's an idea that has become more mature as the apps have been updated, culminating in its implementation in Publisher. It might have been nice to see the Export Persona in Publisher, for fine-tuning PDF files or web images, but the standard "File → Export" does a good job.

BUILD IT

CHRISTIAN GUYTON, STAFF WRITER

Video-Editing Powerhouse

In need of a new rig for editing video? Look no further

LENGTH OF TIME: **1-2 HOURS**

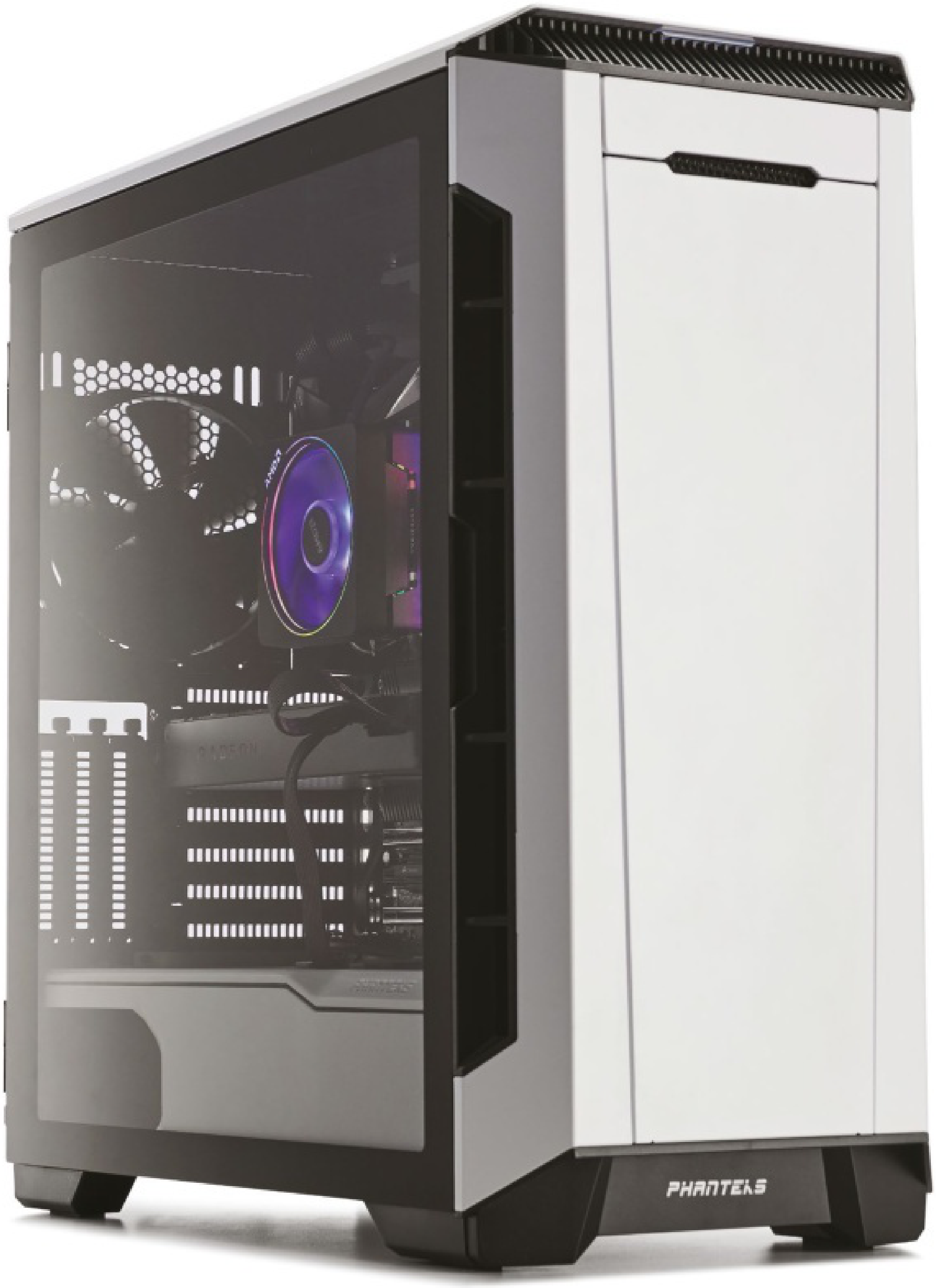
LEVEL OF DIFFICULTY: **EASY**

THE CONCEPT

INSPIRED BY a handful of reader letters, this issue we're building a video-editing machine. The most dedicated readers among you might recognize the case as the same one we used for a previous video-editing build, but this time the internals are very different. With AMD releasing a bevy of new components, we knew it was time to put some of them to the test in a new rig. We also tried to stick to a relatively sensible budget for a workstation PC, setting ourselves a goal of $2,000.

Without blowing closer to $3,000, we won't be making a godly beast of a computer dedicated to 4K video editing. What we're producing is an effective but not overpriced workstation, ready for all manner of office work, as well as video editing, image manipulation, and audio work. Flexibility was key: A system that could carry out complex tasks quickly and effectively. There was a dual purpose, though: Testing the capabilities of the array of new hardware from AMD. While we've played around with individual components, this is our first build properly featuring the new hardware; that means a next-generation CPU and GPU from AMD, as well as a new motherboard and drive, to produce a build capable of taking full advantage of the new NMVe Gen4 and PCIe 4.0.

For this rig, as with all PCs built with editing in mind, we needed a powerful CPU, capable of performing processor-intensive tasks such as rendering and video encoding. For that, we're using one of the more powerful new 3000-series Ryzen CPUs: the Ryzen 7 3700X, with a base clock of 3.6GHz, and a potential boost clock of 4.4GHz. Let's see how this brand new system turns out.



READY TO EDIT

WHILE THE PHANTEKS Eclipse P600S can come with some flashy LED lighting options, we're forgoing all that and sticking with the simple, clean-cut appearance of the white model. That's not to say we're abandoning all lighting whatsoever, mind you; the Ryzen 7 3700X's stock cooler comes with some flashy RGB effects, and we're pairing it with some Corsair Dominator Platinum RGB, a four-piece kit that comes with 48 individually addressable LEDs. Yikes. So, lighting is pretty much sorted. That's good, given that the Gigabyte X570 Aorus Master only has some very subtle orange lighting on one edge, and the Radeon RX 5700 has no lighting whatsoever.

We like the look of the RX 5700, in fact. Unlike the odd dented appearance of the 5700 XT, the standard 5700 model from AMD is a sleek gray oblong of brushed metal that reminds us of older cards. It's a quality product that doesn't cost too much, and while users handling extremely high-res footage (think 8K) will want something more powerful, it'll comfortably handle most editing work.

Adding to that is a slick new NVMe Gen4 M.2 SSD, Corsair's 1TB MP600. The new X570 motherboards are prepared to handle massively faster M.2 transfer speeds with NVMe Gen4, so for a system that will likely be transferring large files on a regular basis, this is ideal. Surprisingly enough, this system won't draw too much power without some pretty savage attempts at overclocking, so we're sticking in one of Fractal Design's brand new PSUs. The Swedish manufacturer has danced with power supplies before, providing its Integra PSUs (integrated power units, in case the name didn't give that away) for several of its cases. Its new Ion+ series are high-quality modular PSUs, available in a variety of wattages. We're using the 560W model, because it provides enough power for our system without breaking the bank.

INGREDIENTS

PART		STREET PRICE
Case	Phanteks Eclipse P600S White	$150
Motherboard	Gigabyte X570 Aorus Master	$360
CPU	AMD Ryzen 7 3700X	$329
CPU Cooler	AMD Wraith Prism (stock cooler)	N/A
Memory	Corsair Dominator Platinum RGB 4x 8GB @ 3,600MHz	$320
GPU	AMD Radeon RX 5700	$350
PSU	560W Fractal Design Ion+ 560P	$100
Storage	Corsair MP600 Force Series Gen4 1TB M.2 SSD	$250
OS	Windows 10 Home 64-bit	$100
Total		$1,959

1

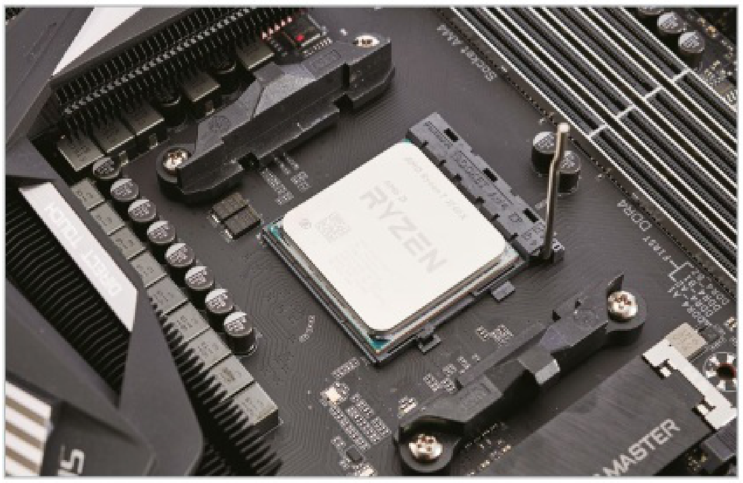
DO OR DISASSEMBLE

THIS MIGHT BE the easiest case to prep we've ever come across. The side panels—one glass, one metal—open with magnetic clasps, and swing out on hinges, from where they can be easily lifted off. Meanwhile, the front and top panels are secured solely with magnets. Make sure the cables from the front I/O and the PWM fan hub (at the top) are nice and tidy in advance, using the Velcro straps Phanteks has provided. We're using all the stock case fans, so there's no fiddling around to be done. Feel free to remove any drive cages or mounts for HDDs and SATA drives, as we're sticking to M.2 storage for this build. Lastly, make sure your build area is clear and you have all the tools you need: a Phillips head screwdriver, thermal paste, and a bowl for your screws.

2

THE YEAR 3000

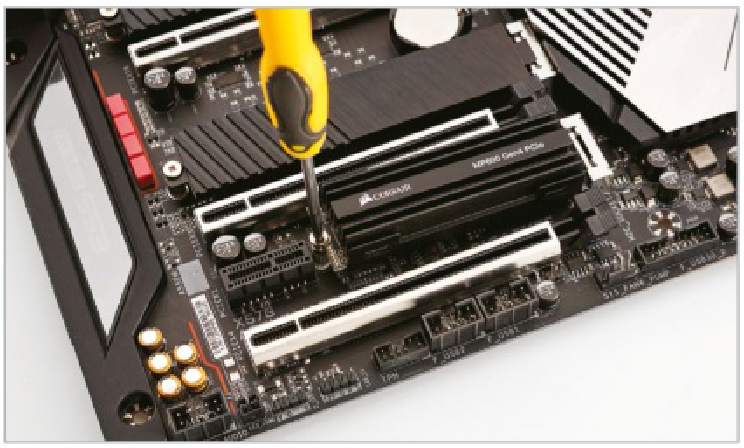
THE P600S is quite bulky, so we'll prep the motherboard assembly outside the case. Like many of the new X570 mobos, heat shielding and dedicated cooling mean that the Aorus Master is pretty heavy, so be careful when removing it from the antistatic cover. Unless you've got a dedicated workspace, use the box it came in as a surface to mount it as you add components. Start with the processor: Simply lift the retention arm, line up the gold corner of the chip with the triangle on the bracket, drop it into place, then lower the arm so it locks in position. Moving on, this mobo has four DIMM slots; that's exactly how many sticks of RAM we're using—how convenient. Release the clips at either end of the slots, then push the sticks into place until they click on both sides. All done!



3

HIGH-SPEED PURSUIT

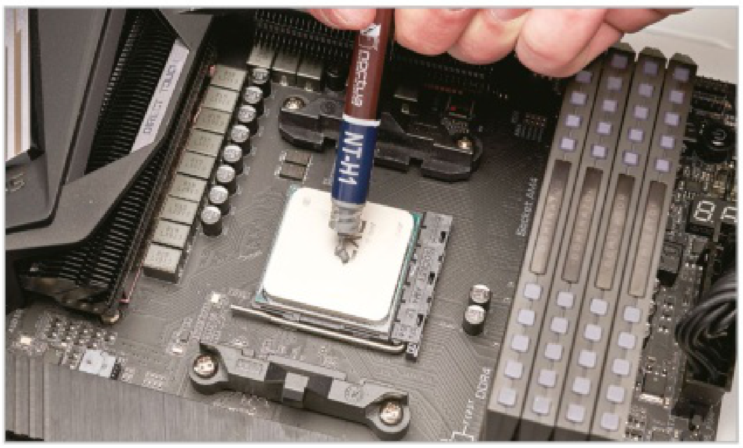
HOW WE LOVE THE NVMe Gen4 M.2 drives. The transfer speeds are monstrous. What we're not so sure about is manufacturers slapping (often ugly) integrated heatsinks on them, when the X570 boards that support them almost unilaterally have their own heat management solutions. Such is the case here, although the Corsair MP600 looks very inoffensive. Unscrew the smallest of the Aorus Master's three M.2 heat spreaders and remove it, then fit the MP600 drive into place, and screw it down. Put that loose heat spreader somewhere you won't lose it! If you'd prefer to use it, the MP600's heatsink can be removed by pushing in the two clasps on either side. Take off the plastic cover on the sticky pad beneath the heat spreader you removed from the mobo, and ensure the M.2 drive is properly attached before you screw it back in.



4

PRISMATIC

WITH MOST of the components in place, the next step is to install the motherboard. This is pretty straightforward; lay the case on its side, then lower the board in before screwing it down, being careful to fit the rear I/O beneath the fitted case fan. As is often the case, you may have some difficulty, so if the fan gets in the way, remove it and reinstall it to the rear of the case once the motherboard is secured. Now get the Wraith Prism cooler ready. Your mobo should come with two AMD stock standard clips fitted either side of the CPU socket—if not, fit those first. Once affixed, apply a small blob of thermal paste to the CPU (we're using Noctua NT-H1 compound) before lowering the cooler into place, and making sure both clips are hooked to the bracket. Pull the clasp so it locks into place, and your cooler is secured.



5

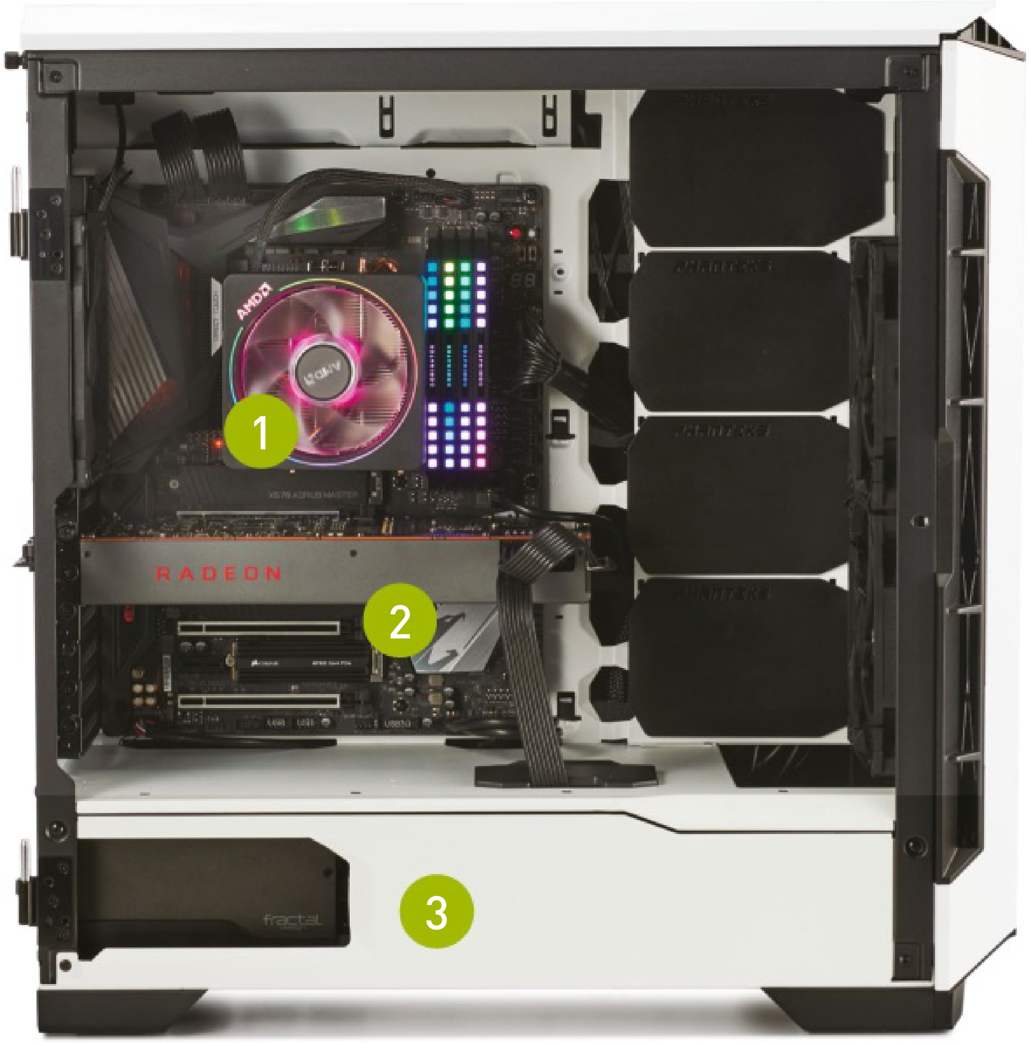
RADEON-ATION

BE WARNED: If you have gargantuan paws like our six-foot-three staff writer, you may wish to skip to step six before installing the GPU. While we usually try to get all the components fitted before messing with cable management, we found that squeezing in some of the cables from the front I/O proved tricky once the GPU was in place. The Radeon RX 5700 is lovely looking, though; it feels solid and fits nicely in the case. Remove two of the blanking plates at the rear of the case. Make sure the PCIe slot's clasp is open, then push the card into it, so it clicks into place, before securing it to the backplate with the screws that had secured the blanking plates. The RX 5700 is heavy, so secure it tightly, and be careful not to drop it on your mobo, lest you damage other components.

6

MISCHIEF MANAGED

LASTLY, WE INSTALL the PSU. The Ion+ 560P is modular, so you need to sort out which cables you require. You need the thick 28-pin connector for the mobo, and two eight-pin connectors for the CPU. The GPU takes one eight-pin and one six-pin connector; you can find both on one cable, in the form of two six-pin and two two-pin connectors. For the eight-pin GPU slot, fit one of the two-pin connectors to the side of the attached six-pin one. Lastly, you need one SATA accessory connector, for powering the PWM fan hub. Next, fit the PSU at the rear and run the cables through to the sockets on the board. The P600S has plenty of slots and Velcro straps for cable management, so tidy up the cabling to the rear of the motherboard plate before sealing this big white box shut.



1 While it might only be the stock cooler for the 3700X, the Wraith Prism is actually very effective when it comes to keeping your processor cool. It looks pretty good, too, and doesn't impinge on the DIMM slots, even with bulkier RAM.

2 The RX 5700 is a great mid-range GPU, and there's always room for upgrading in this build. We're still waiting on a high-end card from AMD, though....

3 The PSU shroud has plenty of space to conceal any loose cables, but thanks to the modular design of the Ion+ 560P, there shouldn't be too much of that nonsense to deal with.

A QUALITY RIG WITH ROOM FOR IMPROVEMENT

WE'RE PRETTY PLEASED with the outcome of this build. It might not be as optimized for gaming as some of our "Build It" PCs—though it should still handle most games at 1440p—but it smashed our benchmark zero-points in other areas. The Gen4 M.2 drive is pulling its weight and then some, getting close to a dizzying 5GB/s of read speeds and over 4GB/s of writes. Meanwhile, the Ryzen 7 3700X and Radeon RX 5700 both did great, performing well in Cinebench and 3DMark.

Were price no object, or if we were focusing on extremely high-end performance, we'd have spruced up some parts of the build. This system could comfortably support a high-end GPU, such as a Radeon VII or an RTX 2080 Ti, without starting to struggle, although for extreme 8K video editing, it may be worth upgrading to 64GB of RAM, too. As a mid-level workstation, though, this rig is easily capable of doing the work. The 3700X is a quality CPU; we did contemplate using a Ryzen 9 3900X, but the price increase against performance didn't seem worth it.

The Gigabyte X570 motherboard is a great, dependable board for supporting a flexible build, and likely won't need upgrading for a long time. The Eclipse P600S also leaves plenty of room for expansion, with space for a larger GPU or a soundcard. There's also room for an all-in-one cooler; a worthy extra if you're looking to overclock. The Wraith Prism is actually a fantastic cooler, considering it comes with the 3700X, and it can comfortably handle the CPU's automatic overclocking functions without overheating. Ryzen 3000 processors have some issues with manual overclocking, but if you've got the expertise to make it work, a more robust cooling solution may be required.

These builds often serve as more of a guideline than a hardline tutorial, so we expect you to swap out components here and there. One part we recommend, though, is the Fractal Design Ion+ PSU. Its modular design and clean appearance make it a very attractive choice of power supply. It also comes in 660W, 760W, and 860W models, should your system need a little extra juice.

It's hard not to like this build. The setup was straightforward and the end result is a pleasingly simplistic system that runs well and looks good; the RGB lighting is restrained, but flashy enough to impress. The only other thing we'd consider adding is a hard drive, because our MP600 only packs 1TB of storage. It might sound a lot, but for storing large video files, slapping in a roomy HDD might become a necessity.

BENCHMARKS

	ZERO-POINT	
Cinebench R15 Multi (Index)	959	2,096 (119%)
CrystalDisk QD32 Sequential Read (MB/s)	3,442	4,998 (45%)
CrystalDisk QD32 Sequential Write (MB/s)	1,706	4,286 (151%)
Rise of the Tomb Raider (fps)	95	84 (-12%)
Total War: Warhammer II (fps)	55	55 (0%)
Tom Clancy's Ghost Recon Wildlands (fps)	48	51 (6%)
3DMark: Fire Strike (Index)	9,128	20,755 (127%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point consists of an Intel Core i5-8400, 16GB (2x 8GB) of Corsair Vengeance LPX @ 2,666MT/s, an MSI GeForce GTX 1080 Armor, and a 500GB Samsung 960 Evo M.2 PCIe SSD. All tests were performed at 1440p at the highest graphical profile.

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REVIEWS

TESTED. REVIEWED. VERDICTIZED.

ASROCK X570 TAICHI **PAGE 82**

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AMD Ryzen 7 3700X

Building a better mainstream eight-core chip

AMD'S THIRD-GENERATION Ryzen CPUs boast higher clock speeds and more cores than the first and second-gen parts. In fact, Zen 2 CPUs are so good that AMD almost doesn't need the faster offerings—its second-string 3700X is perfectly capable of running the offense, and it isn't quite as demanding when it comes to signing bonuses and contracts. For those teams (aka PCs) with salary cap concerns that can't quite justify chasing the 3900X, the 3700X is a versatile QB that can throw a quick short pass, scamper downfield for a modest gain, or even launch the long ball when required.

When it comes to playing football—in other words, running PC games—there's not a huge difference between the 3700X and the 3900X. In fact, there's hardly any difference at all. Out of 10 games tested, it's effectively a tie, with the 3900X hanging on to a scant 0.5 percent lead in frame rates. That's well within the margin of error, and that's with an RTX 2080 Ti at 1080p; move up to 1440p or 4K, or downgrade to a slower GPU, and the gap would almost completely disappear.

What about Intel's Core i9-9900K? That chip is measurably faster, by around 9 percent in games, but again only when looking at the fastest GPU and a modest 1080p resolution. It also costs about $200 more, once you factor in aftermarket cooling. Hit the showers and leave the field of games behind, and differences between the 9900K and 3700X become even less noticeable. If you really need that final 5 percent performance boost and are willing to pay for it, you're probably already looking at the 3900X instead, which remains out of reach of Intel's mainstream parts, thanks to AMD currently packing 50 percent more cores.

DRAFT PICK

All of the Zen 2 architectural updates are definitely a factor, and TSMC's 7nm process gives AMD a manufacturing lead over Intel for the first time in... ever. Look no further than power use, where the 3700X topped out at 179W for heavily multithreaded workloads compared to the 9900K's 242W. Intel's 10nm node is now shipping, and may ultimately prove similar or perhaps even superior to TSMC's 7nm, but it's only in laptop parts and that doesn't look set to change anytime soon. Instead, the 10th Gen 14nm Comet Lake Intel processors will keep Intel's desktop play-off hopes alive. Which still feels incredibly weird.

Maybe Intel will drop prices on its CPUs a bit, probably there will be a 10-core mainstream CPU, but until and unless that happens, the plucky underdog AMD continues to make waves in the world of processors. It's also ready for PCIe 4.0 graphics cards and storage, neither of which really appears to be all that necessary right now. Still, everything else being equal, why wouldn't you want the newer, faster interface?

With third-generation Ryzen, AMD effectively sounds the death-knell for HEDT platforms. We love extreme performance, and the idea of 28-core and 32-core HEDT processors is still exciting. But when you can get eight-core chips for $329, and 12-core chips for $499, is it really worth the added cost? Are any of us really doing enough to warrant upgrading to a more expensive mobo, memory, CPU, and PSU? HEDT becomes a niche within a niche for non-workstation users.

Ryzen 7 3700X is a great CPU overall, and it's arguably the sensible choice for most users. Why blow a ton of cash on your CPU and then have to cut back on your graphics card, storage, motherboard, and/or memory? Bang for the buck is always better if you step down a notch or two from the top-of-the-line parts. *Maximum PC* often leans more toward raw performance, but there's nothing wrong with backing off a bit and getting a potent part at a reasonable price. Just don't plan on massive overclocks, because you're better off sticking with stock performance this round (see "Tech Talk" on page 15). **–JARRED WALTON**

VERDICT
9

AMD Ryzen 7 3700X

➕ SUPER BOWL Efficient; fast; affordable.

➖ PRO BOWL Weak overclocking potential; still slower in games.

$329, www.amd.com

BENCHMARKS

	AMD Ryzen 7 3700X	Intel Core i9-9900K
Blender 2.80 Beta BMW (pps)	3,041	**3,280**
Cinebench R15 Single (Index)	204	**221**
Cinebench R15 Multi (Index)	**2,119**	2,073
POV-Ray 3.7.1 Single (pps)	508	**624**
POV-Ray 3.7.1 Multi (pps)	4,569	**5,477**
PCMark 10 (Index)	7,169	**7,820**
Metro Exodus (fps)	93	**95**
Division 2 (fps)	145	**152**
Total War: Warhammer II (fps)	99	**108**

Best scores are in bold. Our test bed consists of an Asus ROG Crosshair VIII Hero Wi-Fi (X570) motherboard, 16GB of G.Skill TridentZ Royal DDR4-3600, an Nvidia GeForce RTX 2080 Ti, and a Gigabyte Aorus NVMe Gen 4 1TB SSD. All games are tested at their highest graphical profile, at 1080p.

SPECIFICATIONS

Base/Turbo Clock	3.6/4.4GHz
Cores/Threads	8/16
Lithography	7nm
Cache	32MB L3
Memory Support	128GB DDR4
Memory Channels	2
Max PCIe Lanes	16
Graphics	N/A
TDP	65W

AMD Ryzen 7 3700X
AMD
RYZEN
100-000000071
BF 1925SUT
9HP0850R90152
DIFFUSED IN USA
DIFFUSED IN TAIWAN
MADE IN CHINA
© 2019 AMD

The Ryzen 7 3700X doesn't dazzle with a dozen cores, but it's still an impressive CPU.

RTX 2080 super
NVIDIA

It's technically better than last year's model, by a small margin.

Nvidia GeForce RTX 2080 Super

No Founders Edition premium makes this a decent $700 card

WITH NO REAL THREAT from AMD at the high end, the RTX 2080 and 2080 Ti remain unchallenged. Still, it's nearly a year after the launch of the GeForce RTX cards, and just in time for the back-to-school season, Nvidia's new and improved product is now available. Take the same TU104 GPU that's used in the RTX 2080, enable all of the streaming multiprocessors and CUDA cores, and crank the GDDR6 memory clock up from 14Gb/s to 15.5Gb/s. Depending on your reference point, GPU clocks are either nearly the same or about 100MHz faster. In other words, it's not an incredibly exciting launch. If you've got an RTX 2080, you can get nearly the same performance via overclocking. If you've been thinking about buying a $700 graphics card, though, the RTX 2080 Super now claims top honors—and there's no $100 price premium if you buy direct from Nvidia.

There's a bit more separation between the 2080 Super and the 2070 Super, because only the 2080 Super gets 15.5Gb/s GDDR6. Clock speeds have been pushed about as far as you're likely to see. Sure, you can probably squeeze a few percent more performance out of the card via manual overclocking, but it's definitely going to be a case of diminishing returns. The TDP has already jumped 35W compared to the 2080.

In terms of features, nothing has changed since last year's GeForce RTX launch. At 1440p, for example, the 2080 Super is 5 percent faster than the 2080, which in turn is 7 percent faster than the 2070 Super. Other resolutions tell a similar story, although 1080p starts becoming CPU-limited at times. The 2080 Super is only 2–3 percent faster on average than a 2080 at 1080p, while at 4K, the added memory bandwidth does help a little bit, and it's 6 percent faster—11 percent more memory bandwidth is nice, but not really necessary. Meanwhile, there's only 5 percent more compute performance relative to the 2080, which is why the gains in performance are all less than 11 percent, and often less than 5 percent.

VALUE JUDGMENT

The RTX 2080 Super still does great as a card for gaming at 1440p, averaging more than 60fps in every game we tested. 1080p ultra and 144Hz is also mostly viable, although you'd want a G-Sync display. The only problem is that the exact same thing can be said of the RTX 2080. If all 2080 cards were still priced at $700 and up, the 2080 Super would be an easy recommendation. Instead, we have RTX 2080 cards starting at $610, and factory overclocked models for $650. In terms of frames per dollar spent, it's pretty much a wash.

The only cards that are substantially faster than the RTX 2080 Super are currently priced so high that only the deepest pockets can reach. The RTX 2080 Ti is about 20 percent faster overall at 4K, but it costs about 50 percent more. Meanwhile, the Titan RTX is 25 percent faster overall at 4K, and costs more than three RTX 2080 Super cards.

We're still waiting to see a killer app for Nvidia's ray-tracing hardware. The performance hit is far too steep in most games. Developers need to figure out a way to significantly boost ray-tracing performance so that the final results actually look significantly better while still delivering acceptable performance. However, we worry that it won't be until the next generation of Nvidia GPUs that we have the hardware necessary to truly tackle real-time ray tracing without compromising performance. Let's hope some clever software developers prove us wrong.

The GeForce RTX 2080 Super ends up as the typical update to an existing product. Yes, it's faster than the previous iteration, but not markedly so. If you already have an RTX 2080, you can carry on without losing any sleep. If you're putting together a new PC or upgrading from an existing GPU, and you want something more than an RTX 2070 Super, but can't step up to the 2080 Ti, this will have to suffice. –**JARRED WALTON**

VERDICT **7**

Nvidia GeForce RTX 2080 Super

+ SUPER DUPER Great for 1440p and even 4K; still hope for ray tracing; fastest GDDR6 clocks so far.

− PARTY POOPER Only a little faster than RTX 2080; not at all revolutionary; needs a killer ray-tracing app.

$700, www.nvidia.com

SPECIFICATIONS

GPU	Turing TU104
Lithography	TSMC 12nm FinFET
Transistor Count	13.6 billion
CUDA Cores	3,072
Texture Units	192
ROPs	64
Core/Boost Clock	1,650/1,815MHz
Memory Capacity & Type	8GB GDDR6
Memory Speed	15.5GT/s
Memory Bus	256-bit
TDP	250W
Display Connectors	3x DisplayPort 1.4, HDMI 2.0B, USB Type-C

GPU BENCHMARKS

	Nvidia GeForce RTX 2080 Super	Nvidia GeForce RTX 2080
Tom Clancy's The Division 2 (Avg fps)	**133/90**	126/86
Assassin's Creed Odyssey (Avg fps)	**76/63**	73/62
Far Cry 5 (Avg fps)	**131/112**	**131**/108
Shadow of the Tomb Raider (Avg fps)	**130/97**	**130**/92
Middle Earth: Shadow of War (Avg fps)	**129/96**	120/90
Metro Exodus (Avg fps)	**97/74**	93/71
Total War: Warhammer II (Avg fps)	**104/94**	103/92

Best scores are in bold. Our test bed consists of an Intel Core i7-8700K, 16GB of G.Skill DDR4-3200, a Gigabyte Z370 Aorus Gaming 7, and a 1TB Samsung Evo M.2 SSD. All games are tested at their highest graphical profile with AA turned on, at 1080p and 1440p respectively.

Nvidia GeForce RTX 2060 Super

This card just cut the price of 2070 performance by $100

LET'S JUST GET this out of the way right at the beginning: We think the Super branding could quite possibly be one of the dumbest things we've seen in recent years. We're definitely looking forward to the redundant naming that's bound to come from EVGA: the GeForce RTX 2060 Super SSC (Super Super Clocked). But complaints about naming aside, we're looking at modestly improved core counts.

The Turing architecture behind the new Super RTX cards is identical to existing RTX cards. That means the hardware includes RT cores for DirectX Raytracing and Vulkan-RT, Tensor cores for DLSS and other machine-learning workloads, variable rate shading, mesh shaders, and concurrent integer and floating-point execution pipelines.

The 2060 Super has 8GB of GDDR6, which equates to 33 percent more bandwidth—the same as the 2070 Super. The TU106 has up to 36 SMs (Streaming Multiprocessors), and the 2060 Super has 34 enabled. That puts it right between the old 2060 and the 2070.

In terms of performance expectations, the RTX 2060 Super should be just a tad slower than the RTX 2070, but it should also be quite a big jump in performance over the vanilla RTX 2060. The pricing reflects this, with the new RTX 2060 Super selling for $399 while the RTX 2060 will continue to be sold for $349. That price makes this one of the best graphics cards in terms of value.

The RTX 2060 Super works best as a card for 1080p or 1440p gaming. 4K is often possible at lower quality settings (or with DLSS), but more demanding games tend to be a bit out of reach. Overall, performance is right where you'd expect, based on the specs. The RTX 2060 Super outperforms the RTX 2060 by 10 percent and nearly matches the RTX 2070.

WATCH THE GAP

Nvidia pitches the RTX 2060 Super as a graphics card built for 1440p gaming, and provided we're talking about 60fps, it does generally succeed. With the higher resolution, the added memory bandwidth, thanks to the additional 2GB of GDDR6, starts to show up more when comparing the 2060 Super with the regular RTX 2060. Now the gap is 15 percent on average, with a few games showing even larger gains.

Many felt underwhelmed by Nvidia's RTX 20-series launch—or overwhelmed by the comparatively high pricing. With no games leveraging the new ray-tracing hardware at launch, sales weren't as good as Nvidia hoped. One year later, things are improving, and the 2060 Super is perhaps the best of the RTX line in terms of bang for buck.

There are two ways of looking at the RTX 2060 Super, and how you ultimately feel about the new graphics card will depend on which perspective you take. One view is that it's a slightly faster card than the RTX 2060 and it costs $50 more. That's not super-exciting. The other perspective is much more enticing: It's effectively replacing the RTX 2070 level of performance for $100 less.

If you haven't felt the need to jump on the ray-tracing RTX bandwagon yet, the 2060 Super isn't likely to change your mind. It's arguably more a question of getting the killer ray-tracing app than the hardware, though. *Metro Exodus* looks better with ray-traced global illumination, but it still looks good without it. Until a game comes out that looks so amazing with ray tracing that everyone wants to upgrade, RTX is more of a nice extra than a must-have feature. And maybe it will remain that way for years to come.

The RTX 2060 Super is still a good card. It's faster than a GTX 1080, at a lower price, with new features that may benefit future games. We wouldn't recommend upgrading from a GTX 1080 to an RTX 2060 Super, but if you're running an older GPU and are looking to spend $300 or more on a high-end graphics card, it's a worthy pick. And it makes the prospect of buying AMD's RX 5700 series more difficult. **–JARRED WALTON**

VERDICT
8

Nvidia GeForce RTX 2060 Super

⊞ **SUPERHERO** Good 1080p and 1440p performance; better value than other RTX cards; 8GB GDDR6 beats the vanilla 2060.

⊟ **SUPERVILLAIN** Not many ray-tracing games; didn't inherit the 2060 price; super-dull name.

$399, www.nvidia.com

GPU BENCHMARKS

	Nvidia GeForce RTX 2060 Super	Nvidia GeForce RTX 2060
Tom Clancy's The Division 2 (Avg fps)	**95/64**	83/55
Assassin's Creed Odyssey (Avg fps)	**63/53**	62/48
Far Cry 5 (Avg fps)	**121/90**	109/78
Shadow of the Tomb Raider (Avg fps)	**110/82**	100/72
Middle Earth: Shadow of War (Avg fps)	**103/73**	88/57
Metro Exodus (Avg fps)	**76/56**	65/48
Total War: Warhammer II (Avg fps)	**97/76**	92/68

Best scores are in bold. Our test bed consists of an Intel Core i7-8700K, 16GB of G.Skill DDR4-3200, a Gigabyte Z370 Aorus Gaming 7, and a 1TB Samsung Evo M.2 SSD. All games are tested at their highest graphical profile with AA turned on, at 1080p and 1440p respectively.

SPECIFICATIONS

GPU	Turing TU106
Lithography	TSMC 12nm FinFET
Transistor Count	10.8 billion
CUDA Cores	2,176
Texture Units	136
ROPs	64
Core/Boost Clock	1,470/1,650MHz
Memory Capacity & Type	8GB GDDR6
Memory Speed	14GT/s
Memory Bus	256-bit
TDP	175W
Display Connectors	DisplayPort 1.4, HDMI 2.0B, DVI-DL

RTX 2060 super
NVIDIA
NVIDIA CORPORATION
Santa Clara, California, USA

Nvidia's own card design still looks appealing, now without a Founders Edition price tag.

RADEON
RADEON

The RX 5700 is a step down from the 5700 XT, for a reasonable $50 less.

AMD Radeon RX 5700

A good alternative that isn't quite as beefy or handsome as the 5700 XT, for a lower price

THE RADEON RX 5700 is the second of AMD's new Navi 10 graphics cards, sporting the new and improved RDNA architecture, and playing second fiddle to the RX 5700 XT's leading role. It's a story we've seen many times—the RX 570 was a modest step down from the RX 580, same for Vega 56 compared to Vega 64. If you prefer the Nvidia side of things, it's a bit like the GTX 1660 versus the GTX 1660 Ti. Sporting a last-minute price drop, the direct competition is the RTX 2060.

The RX 5700 uses the same Navi 10 GPU as the other 5700 models, but AMD disables four CUs and 256 cores, as well as dropping the boost clock by 180MHz. That's typical for the second-tier product for any GPU, and the reason comes down to chip yields. RX 5700 cards likely won't hit the same clock speeds as the 5700 XT, no matter how hard you try to overclock.

At present, AMD has no support for DirectX Raytracing or Vulkan-RT. It's possible to do ray tracing via compute shaders, and Nvidia has released drivers that do exactly that for the GTX 10/16 series GPUs, but AMD is so far sitting out on ray-tracing support. Perhaps that won't matter during the life of the cards—the RTX 2060 already struggles with even modest ray-tracing effects—but with the next-gen AMD-powered consoles adding ray-tracing hardware support, there is the potential to be left behind.

Overall, pretty much regardless of what setting you choose, the Radeon RX 5700 comes out ahead of the equivalently priced RTX 2060. It's 5 percent faster at 1080p medium, 8 percent faster at 1080p ultra, 11 percent faster at 1440p ultra, and 15 percent faster at 4K ultra—not that we'd necessarily recommend trying to play games at 4K ultra on the card.

Those claims AMD made about improving performance-per-watt by 50 percent or more? They're true, based on our testing. About the only minor ding (other than the lack of DXR-enabled drivers) is that noise levels appear to be slightly higher than Nvidia's cards.

POWER PLAY

If you're rooting for AMD or just sick of Nvidia's stranglehold on the GPU market, the new AMD Navi graphics cards are a great addition. Performance and even price aren't a massive improvement over the Vega cards, but even the slower RX 5700 tends to beat Vega 64 in most games. The fact that it can do so while using a bit more than half as much power is the bigger deal in our book. All things being equal, we'd much rather have a quieter and less power-hungry GPU, and the RX 5700 fits that description. In fact, it's about on par with the RTX 2060 in power use, while providing more performance, and it uses 10–15W less than the 2060 Super. Less power means less noise, less heat, and potentially a smaller PSU.

There's also the question of API support. Whether you like it or not, DirectX Raytracing is now a Microsoft standard. That means more ray-tracing games are on the way, and even AMD has plans to support DXR via hardware acceleration—just not right now. If DXR catches on, and optimizations to improve performance without compromising image quality continue, in a year or two, the Navi 10 GPUs could look like a questionable purchase.

Overall, the Radeon RX 5700 is still a great card and belongs on the list of potential GPU upgrades. If you're looking for the best $350 graphics card today, it's the RX 5700, even if it might not be the better card six months or two years from now. There's also hope that street prices will drop a bit after the initial rush is over. Perhaps most importantly, regardless of whether you want to buy an AMD or Nvidia graphics card, there's more competition now, and that's resulting in better value for everyone. **–JARRED WALTON**

GPU BENCHMARKS

	AMD Radeon RX 5700	**Nvidia GeForce RTX 2060**
Tom Clancy's The Division 2 (Avg fps)	**88/59**	83/55
Assassin's Creed Odyssey (Avg fps)	58/45	**62/48**
Far Cry 5 (Avg fps)	**121/93**	109/78
Shadow of the Tomb Raider (Avg fps)	**111/89**	100/72
Middle Earth: Shadow of War (Avg fps)	**97/60**	88/57
Metro Exodus (Avg fps)	**73/58**	65/48
Total War: Warhammer II (Avg fps)	80/59	**92/68**

Best scores are in bold. Our test bed consists of an Intel Core i7-8700K, 16GB of G.Skill DDR4-3200, a Gigabyte Z370 Aorus Gaming 7, and a 1TB Samsung Evo M.2 SSD. All games are tested at their highest graphical profile with AA turned on, at 1080p and 1440p respectively.

VERDICT

8

AMD Radeon RX 5700

+ **RAD** Efficient and fast; beats Vega 64 and RTX 2060.

− **SAD** No ray-tracing support; louder than RTX cards.

$350, www.amd.com

SPECIFICATIONS

GPU	Navi 10
Lithography	7nm
Transistor Count	10.3 billion
Stream processors	2,304
Texture Units	144
ROPs	64
Core/Boost Clock	1,465/1,725MHz
Memory Capacity & Type	8GB GDDR6
Memory Speed	14GT/s
Memory Bus	256-bit
TDP	180W
Display Connectors	3x DisplayPort 1.4, 1x HDMI 2.0B

The X570 can also support 2000-series Ryzen processors, of course.

ASRock X570 Taichi

Steampunk style on a thoroughly modern mobo

NO, THE COGS DON'T MOVE. We were disappointed, too. Straight out the box, the X570 Taichi from ASRock looks as though it would be just as comfortable behind the control panel of a 1900s steam locomotive as it would inside a new PC build. It's a solid piece, with a full metal backplate and heavy heatsink armor covering much of the board. We dig it. Refusing to be disillusioned by the lack of a piercing steam whistle when we first powered it up, we pressed on.

This is part of the vanguard of X570 motherboards introducing NVMe Gen4 support, which promises insane transfer speeds with M.2 drives. With a compatible SSD plugged in, the numbers speak for themselves. Our benchmark figure is an amalgamated score from several tests, but be assured that the transfer speeds did hit the legendary 5000MB/s on more than one run. These boards are designed to support the new AMD Ryzen 3000 series of CPUs, which promise better performance than ever before.

The further in we got with testing this board, the more pleased we became. Coupled with AMD's new high-end processor, the Ryzen 9 3900X, the Taichi sailed through our benchmarks with ease. ASRock has got the memory frequency nailed this time around; a simple trip into the BIOS to switch on the included XMP profile, and our RAM was instantly up and running at the proper 3,200MHz. It was a slick setup process, only delayed by the need to remove the heat shield from our M.2 SSD in order to install it underneath the board's hefty heatsink plate.

Like most of the newly available X570 motherboards, the Taichi has its own active cooling solution: a dinky 36.8mm fan fitted under the armor, spinning at 5,000rpm, and promising up to 50,000 hours of operating time. There's passive cooling, too, with a large aluminum alloy heatsink on the opposite corner of the board. It's a necessary addition, because the PCIe 4.0 slots on the Taichi demand a significant amount of power when fully equipped; about a third more while idling than previous X470 boards. A 60-Amp power choke and ASRock's smart power phase technology mean that wattage at maximum CPU load is actually lower than on older boards.

CORE STABILITY

Overclocking headroom on the new Ryzen 3000 series chips is pretty limited, though. We weren't able to push the 3900X any further than 4.2GHz across all cores, despite our best efforts. Individual cores can be pushed as high as 4.5GHz, but even that is unreliable and prone to crashes. That's not a reflection on the board, however; the support is there, the chip simply can't handle higher frequencies.

When it comes to I/O support, this motherboard comes prepared. The rear I/O supports HDMI output for CPUs with integrated graphics, six USB 3.2 ports, and a USB Type-C port. There's still a trusty old PS/2 connector, too, although we can't imagine it will see too much use on this mobo. The board itself has headers for USB 3.2, Type-C, and even Thunderbolt 3 ports from the front I/O, although the latter does require an AIC R2.0 adapter. PCIe 4.0 is included as well, with twice the potential speed of the previous generation. The PCIe slots are stainless steel with additional anchor points, ensuring that even heavy GPUs can be safely installed.

Simply put, the Taichi has more in common with a bullet train than a steam engine. The clockwork stylings on the board only run skin deep; underneath, this is a brilliantly adaptive and powerful centerpiece for any new build. ASRock's Polychrome RGB lighting clashes a little with the chrome and dark metal on the board when in its default rainbow mode, but set it to a bright orange or yellow, and this mobo looks awesome. At $300, it isn't a cheap option, but if you're contemplating a high-end new Ryzen processor, this is the board you want supporting it. –**CHRISTIAN GUYTON**

VERDICT
9
KICK ASS!

ASRock X570 Taichi

+ **NUCLEAR POWER** Almighty M.2 transfer speeds; sturdy and attractive design; great I/O support.

− **STEAM ENGINE** High idle power draw; expensive relative to X470 boards; the cogs don't turn!

$300, www.asrock.com

BENCHMARKS

	ASRock X570 Taichi	Asus ROG Strix X470-F Gaming
Tech ARP's X264 (fps)	61.07	**61.84**
Cinebench R15 Multi (Index)	**2,999**	2,994
Fry Render (m:s)	**01:26**	01:32
AIDA64 Memory Latency (ns)	**76**	78
CrystalDisk QD32 Sequential Read (MB/s)	**4,996**	1,741
CrystalDisk QD32 Sequential Write (MB/s)	**4,272**	1,716
Power Draw Idle/Load (Watts)	63/**155**	**47**/162
Total War: Warhammer II (fps)	**58**	**58**
Lowest Voltage @ 4.2GHz (Volts)	**1.17**	**1.17**
Maximum OC Achieved (GHz @ Volts)	**4.2 @ 1.17**	**4.2 @ 1.17**

Best scores are in bold. Our test bed consists of an AMD Ryzen 3900X, 32GB of Corsair Dominator RGB Pro, an Nvidia GeForce GTX 1080, and a 2TB Gigabyte Aorus NVMe Gen4 SSD. Benchmark tests were performed with auto-overclocking turned off. *Total War: Warhammer II* was tested at the ultra preset at 1440p.

SPECIFICATIONS

Chipset/Socket	X570/AM
Form Factor	ATX
Memory Support	128GB DDR4 @ 4,666MT/s
M.2/U.2 Support	3x M.2
SATA Support	8x SATA 6Gb/s
Max PCIe Support	3x PCIe 4.0 x16 (x8x8)
Rear I/O	6x USB 3.2 Gen1, 1x USB 3.2 Gen2, 1x USB 3.2 Type-C, HDMI, PS/2 port, Intel Gigabit Ethernet, Wireless A/C, 5.1 audio-out, optical audio-out

Corsair MP600 1TB

Corsair drops a PCIe 4.0 bandwidth bomb

WANT MORE BANDWIDTH? Get PCI Express 4.0. If only life were quite that simple. Originally published in 2017, the latest 4.0 revision of the PCI Express interconnect is now coming on stream in actual products. AMD's new motherboard chipsets for its latest Ryzen 3 CPUs include PCIe 4.0 support, enabling us to get jiggy with supporting devices. Enter our very first PCI Express 4.0 SSD: the new Corsair MP600 in 1TB trim.

The big news with PCI Express 4.0 is, of course, the doubling in bandwidth. Per lane, PCI Express 3.0 delivers 1GB/s. PCI Express 4.0 bumps that up to 2GB/s. Thus an SSD with a quad-lane PCI Express 4.0 interface has 8GB of bandwidth to work with. It wasn't all that long ago that 8GB/s was a pretty healthy figure for system memory. For storage, it's pretty epic.

Of course, that 8GB/s is the available bandwidth of the interface. It doesn't automatically follow that an SSD will be able to maximize that potential. Arguably even more to the point, additional peak bandwidth doesn't help when it comes to other critical SSD performance metrics, such as random access. Existing SSDs aren't anywhere near the 4GB potential of a quad-lane PCI Express 3.0 interface when it comes to short queue depth 4K random access storage workloads. Adding even more theoretical throughput on top is rather academic in that context.

Regardless, the new Corsair MP600 1TB is a quad-lane M.2 drive based on NAND flash memory, and therefore largely conventional bar the PCIe 4.0 support. It clocks in at a claimed 4,950MB/s for reads and 4,250MB/s for writes. So, its peak performance does indeed exceed the maximum available from a quad-lane PCI-E 3.0 solution, albeit not dramatically.

Corsair also makes some pretty healthy claims for the random access I/O performance, with a peak of 600K IOPS for writes and 680K for reads, albeit those are for a 32-strong queue depth, rather than the shorter depths that are more revealing of day-to-day performance.

CRAZY TALK

Back in the real world, the MP600 pretty much hits its claimed peak throughput numbers, making it both ludicrously quick and the fastest M.2 drive we've ever seen. You're looking at nearly 5GB/s for reads, which is borderline silly. Wind the clock back to 2006 and Intel's Core 2 Duo chips, and that was the kind of bandwidth that high-end CPUs had to make do with. Beyond those peak sequential figures, however, the picture is more mixed.

During sustained internal file copying, for instance, sustained performance eventually drops down to around 400–800MB/s. However, it takes several hundred gigabytes of file copies before performance degrades to that level. Mostly, you'll be getting multiple gigabytes per second of performance. No surprise, then, to find the MP600 beats all comers in our internal file copy benchmark. As for random access, like a lot of quick modern drives, the write performance looks good. QD1 performance of 174MB/s is good but not spectacular. The same goes for the 604MB/s it cranks out at QD4. On the other hand, the 54MB/s of reads the MP600 achieves at QD1 are likewise very good for an SSD based on NAND flash memory. But Intel's 905P Optane drive is nearly two and a half times faster.

The 905P is based on Intel's radical 3D XPoint memory rather than NAND flash, and in many ways not comparable. It's also not nearly as fast when it comes to peak sequentials. All of which means that the new Corsair MP600 1TB is blazing fast by several metrics, but not the new all-around king. Intel's Optane drives are very likely still the weapon of choice in terms of day-to-day computing performance, but for anyone who needs to shunt around very large files as quickly as humanly possible, Corsair's new PCIe 4.0 beastie very much needs to be on their shortlist. **–JEREMY LAIRD**

VERDICT

9

Corsair MP600 1TB

➕ BOMBS AWAY Epic sequential throughput; good 4K performance for a NAND drive.

➖ BOMBED OUT Intel's Optane still much faster in some areas; plenty of PCIe 4.0 headroom left untapped.

$235, www.corsair.com

BENCHMARKS

	Corsair MP600 1TB	Intel 905p 512GB	Samsung 970 Pro 512GB
30GB Internal Copy (Seconds)	**22**	29	29
CrystalDisk 6 Sequential Read (MB/s)	**4,867**	2,632	2,788
CrystalDisk 6 Sequential Write (MB/s)	**4,289**	2,313	2,331
Anvil 4K QD1 Read/Write (MB/s)	54/**174**	**131**/145	48/141
Anvil 4K QD2 Read/Write (MB/s)	111/232	**245**/273	91/**281**
Anvil 4K QD4 Read/Write (MB/s)	215/**604**	**468**/518	152/524

Best scores are in bold. Our test bench consists of an Intel Core i7-8700K, an Asus Maximus X Hero, an Nvidia GeForce GTX 1080, 16GB of Corsair Dominator Platinum DDR4, and a Samsung 850 Evo 250GB OS SSD.

SPECIFICATIONS

Capacity	1TB
Interface	PCIe 4.0 x4
Control Protocol	NVMe
Controller	Phison PS5016-E16
NAND Type	3D TLC
Sequential Read	4,950MB/s
Sequential Write	4,250MB/s
Read IOPS	680K
Write IOPS	600K
Warranty	Five years

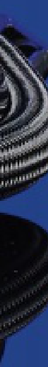
CORSAIR
MP600 Gen4 PCIe

Corsair's new SSD is the first PCIe 4.0 SSD to hit the Maximum PC Lab.

Not just an illusion—the MasterLiquid ML240P Mirage works as well as it looks.

Cooler Master MasterLiquid ML240P Mirage

Cooling in color



THE FIRST THING that strikes us about the MasterLiquid ML240P Mirage is just how much there is in the box. The cooler itself isn't anything unfamiliar—a pump connected to a 240mm radiator by two coolant tubes—but beside the two ARGB fans, there are brackets for various CPU sockets, a sturdy plastic RGB controller, and a massive assortment of wires and connectors. It's a little intimidating, but at $160, this is hardly a cooling solution for the FNG of system building.

Don't be daunted by that box of loose bits and pieces, though—you won't be using most of it. Cooler Master has just done its utmost to ensure system compatibility here. The MasterLiquid ML240P Mirage is compatible with just about any modern CPU, including TR4 sockets for Threadrippers. Assembling the backplate proved more than a little awkward, and there are far too many screws involved here; having to fit 12 different screws (and four stand-offs, with four plastic clips) made us yearn for the clip-on simplicity of Corsair's AIO brackets. Once it's fixed in place, however, it's the Mirage's time to shine. Or shimmer enticingly, perhaps.

We used a shiny new Ryzen 9 3900X processor for our testing, which proved a struggle, given the new chips' problems with overclocking. Happily, we were able to hit a perfectly stable 4.2GHz overclock using AMD's own Ryzen Master software—no BIOS meddling needed here. We compared the ML240P Mirage to the 3900X's stock cooler, the AMD Wraith Prism, and you can see the full results below. The Prism is an excellent air cooler, considering that it comes bundled with the CPU, but the Mirage blew it pretty comfortably out of the water.

SILENT DISCO

Even overclocked and under heavy load, the CPU never broke 50 C with the Mirage cooling it. The cooling quality is undeniable; on an older processor, this will likely provide all the heat management you could need, and we'd say it's a good choice for the new AMD chips, too. The tubing feels durable, but isn't difficult to flex into position, the sleeved exterior giving it a high-quality appearance. And it's quiet; the pump impeller is powered by a PWM motor with a silent driver, keeping the coolant flowing while maintaining a minimal decibel count. The fans run softly as well, using a design with an outer ring that connects all the blades into one solid piece of plastic for minimal fan distortion.

Of course, one of the key selling points here is style. Two ARGB fans is nothing mind-blowing, but Cooler Master didn't stop there. The coolant pump has a transparent plastic cap with an LED module beneath it that illuminates both the visibly spinning impeller and the outer ring of the pump module itself. It's a lovely looking piece of hardware.

The lighting is all designed to be compatible with RGB mobos, enabling easy synching, although using Cooler Master's own lighting control software is generally a better option. The Mirage also comes with an RGB controller, which requires an obscene number of cables to connect. Getting this cooler set up for maximum lighting control is a rather rage-inducing exercise, requiring some serious cable management skills. Included connector brackets and splitter cables make this process easier, but it's still more complicated than it ought to be.

One of the selling points is the Mirage mode effect, which supposedly does... something. To be honest, we're not quite sure. We think it might make the colors a little brighter by adding a touch of white backing to the LED spread, but it takes longer to set up than simply plugging in the controller and finding a preset light pattern that works for you. Now we're just complaining about little things, though; we actually really like this cooler. The flaws we've mentioned are mere squished bugs on the windshield of a 1969 Boss Mustang—easy to look past and admire the powerful machine underneath. **-CHRISTIAN GUYTON**

VERDICT
9

Cooler Master MasterLiquid ML240P Mirage

+ OASIS Top-quality cooling; visually appealing; very customizable.

− DEHYDRATED Too many cables; Mirage mode doesn't much.

$160, www.coolermaster.com

BENCHMARKS

	MasterLiquid ML240P Mirage	AMD Wraith Prism
Idle CPU Temperature (C)	**29**	31
Prime 95 @ Stock (C)	**42**	51
Cinebench R15 @ Stock (C)	**39**	47
Ghost Recon: Wildlands @ Stock (C)	**38**	46
Prime95 @ 4.2GHz (C)	**46**	58
Cinebench R15 @ 4.2GHz (C)	**43**	49
Ghost Recon: Wildlands @ 4.2GHz (C)	**39**	49

Best scores in bold. Our test bed consists of a Ryzen 9 3900X, 32GB of Corsair Vengeance RGB Pro DDR4-3200, an ASRock X570 Taichi, an Nvidia GeForce GTX 1080, a Corsair Neutron 240GB SSD, and a Be Quiet! Dark Power Pro 1,200W PSU.

SPECIFICATIONS

Socket Compatibility	Intel LGA2066, LGA2011-v3, LGA2011, LGA1151, LGA1150, LGA1155, LGA1156, LGA1366, LGA775, AMD TR4, AM4, AM3+, AM3, AM2+, AM2, FM2+, FM2, FM1
Radiator Size	240mm
Radiator Dimensions	10.9 x 4.7 x 1.1 inches
Cold Plate Material	Copper
Fan Airflow	60.95 cfm
Fan Noise	27dBA
Warranty	Five years

NZXT H510 Elite

An elite update to an already great case

WE'RE BIG FANS of NZXT's H-series cases, so were eager to get our hands on the latest model. The previous H510 and H500-series cases were all quality products, and the Elite variant builds upon their best features, while adding some new, flashy extras. The design is as simple and elegant as ever, looking best in the clean-cut white. This is a case for serious builders who want their system to run fast and look good in the process.

First, let's go over the basic features. The H510 Elite feels sturdy and straightforward, with tempered glass panels on one side and the front, behind which two NZXT-branded 140mm RGB fans lurk. A smaller fan sits at the back, and there's a PSU shroud concealing the bottom of the case. A hard drive cage lurks down there, too, out of sight, while two mounting brackets for 2.5-inch SSDs sit behind the motherboard plate. There's a simple vent on the roof, and another one (protected by a removable dust filter) beneath the PSU mounting. So far, business as usual. We could be describing almost any case.

So, what's different? The H-series is somewhat infamous for the large metal strut that runs through the central case cavity, bending at a right angle and concealing multiple clips for securing cables on its rear. Cable management is a priority for NZXT, and this case is no exception. Velcro straps and guiding plastic channels curve around the rear of the motherboard plate, creating paths for organized bundles of cables that feed through to the mobo. Most of these can be removed, allowing for greater customization. Considering the number of cables already in this case before we even begin to build in it, it's a very tidy affair. The PWM fan and lighting control hub is enclosed in a clearly labeled plastic case, looking significantly better than the haphazard chunks of silicon we see screwed into cases all too often.

The front I/O is a simplistic affair that works well with the minimalist design of the case's exterior, though it could be argued that it's a tad too limited. Besides the round, plain power button, a single USB 3.1 port sits next to a single USB Type-C port, then a standard 3.5mm audio jack. Rather pleasingly, they are arranged from smallest to largest. The pleasing visuals of this case don't end there, either; there are vertical brackets for showing off your GPU in an upright position, and a strip of fully addressable LEDs along the top interior rim of the glass window, in addition to the RGB fans at the front. This is no stick-on rubberized lightstrip, either—it's 10 LEDs mounted into a removable plastic frame.

We really don't have many criticisms of the H510 Elite—at least, not ones that we couldn't level at almost any case. Some parts of the steel interior feel a bit flimsy, particularly the perforated top of the PSU shroud, which flexes if you apply some pressure. Radiator capacity is also a little limited, but the front fans are easy to remove should you decide that 140mm of radiator isn't enough. Rather than removing the front glass panel, the whole interior bracket can be easily detached from the inside via two screws. There's plenty of space to run cables through to the motherboard, too; no stuffing 28-pin connectors through tiny holes here.

So, yes, it's a genuinely great case. Once price comes into it, though, we started to get a little nervous. The Elite will set you back $170, making it feel pricey, given what it offers in comparison to the other H510 models. The original version only costs $80, while the H510i—which includes almost everything the Elite offers—will run you $110. Neither of these have the glass front panel and RGB fans, though; it's a premium to pay for superior appearances. This increased price is really the only thing holding the Elite back from being near-perfect; were it maybe 20 dollars less, we'd be even more enthusiastic. –CHRISTIAN GUYTON

VERDICT
9

NZXT H510 Elite

⊞ **RULING ELITE** Brilliant cable management solutions; elegant visual design; great lighting effects.

⊟ **ELITE DANGEROUS** Somewhat limited radiator capacity; a bit pricey.

$170, www.nzxt.com

SPECIFICATIONS

Form Factor	Mid-tower
Motherboard Support	ATX, mATX, ITX
Colors Available	White, black
Window Available	Yes
3.5-Inch Support	3
2.5-Inch Support	2
Radiator Support	280mm front, 120mm rear
Fan Support	2x 140mm front, 1x 140mm roof, 1x 120mm rear
Dimensions	8.3 x 18.1 x 16.9 inches
Graphics Card Clearance	15 inches
CPU Tower Clearance	6.5 inches
Weight	16.5lb

SteelSeries Apex 7

Does this mark the apex of the trajectory of mechanical keyboards? Er, no

STEELSERIES'S APEX 7 sits in a difficult position. It's an Apex Pro in all but its switches—and given that the Apex Pro's customizable hall-effect switches are (in theory) pretty much the most interesting keyboard controls of a generation, it's not immediately clear where the Apex 7, a linear-switched board that's a mere $40 cheaper, stands. Is it good enough, without that gimmick, to sit so high on the price ladder? In its own bubble, at least, it's certainly a feast for the eyes. The RGB lighting hits you first, and it hits hard—both the key illumination and background coronae are absolutely superb, with a bright glow that seems to have been tuned away from the lurid side of RGB and into a more hip, warm, retro zone. Don't worry, though—the requisite buckets of RGB rainbow vomit are present and correct if you want them. The lighting smarts keep stacking up: There are nice reactive effects, and there's an AFK option, which lets you pick a different illumination when you're away from your PC. You can even map an animated GIF on to the keyboard, because why not?

You can also map a custom logo on to the OLED screen at the Apex 7's top-right corner. That's neat, although using the clicky roller (which is lovely) and multifunction button (just OK) to interact with the on-board controls only allows you to take a broad-strokes approach to your keyboard's configuration, with the rest done in software. SteelSeries does offer a number of apps to add a little more functionality to the screen—a Tidal "now playing" integration, and a Discord one, to name the two most notable—but these are pretty limited; it is at least a lot more useful when pulling up on-board profiles on machines that don't have SteelSeries Engine installed.

Full marks for compactness, an aspect of keyboard design at which SteelSeries always seems to excel. There's basically no wasted space, with that roller sitting on the corner of a very minimalist soft-edged aluminum and plastic base, and a magnet-attached wrist rest with a pleasing (though we suspect not wear-resistant) soft-touch coating. Even the hard-wired two-port pass-through cable, fully routable through channels on the base, is mercifully thin compared to the majority on the market, and the illumination around that Type-A port is a wonderful touch. Additional design points go to the ABS keycaps and their bold, clear lettering, although the top-left offset marking of the main cluster may steer your fingers wrong if you're not a touch typist.

CAUGHT RED-HANDED

The eagle-eyed among our readers may notice that we've so far avoided talking about the switches in detail. Really, we almost couldn't bring ourselves to do so. Made in collaboration with Gateron, and clearly designed to ape Cherry's MX Red line, they're no doubt effective linear switches. They're fast and easy to actuate, they're very quiet indeed, and they're reasonably resistant. Problem is, they're also a little swampy, squidgy, and indefinite, with a soft (yet somehow slightly scrapy) feel that we simply do not like. We prefer Cherry's take on Reds—and given that we find those to vary, depending on how they're applied, between passable and awful, that's quite the statement. Yes, switch taste is a personal thing. You may lay one finger on this and fall in love. Who are we to say you're wrong?

However, there's one more aspect that's not so divisive: the price. Does the gimmick of an OLED screen, which is certainly much more useful in configuring the actuation point of the Apex Pro than it is messing about with lighting or sparse app integrations here, really put this keyboard in a higher bracket? No. It's special, solid, handsome, and very well designed, but it's way more expensive than it should be. Chop that screen away and slice off something like 40 bucks, and the Apex 7 would hit the mark. **–ALEX COX**

VERDICT
6

SteelSeries Apex 7

➕ **APEX** Fabulous looks; excellent lighting options.

➖ **HUNT AND PECK** Slightly redundant OLED screen; switches aren't a win for us; too expensive.

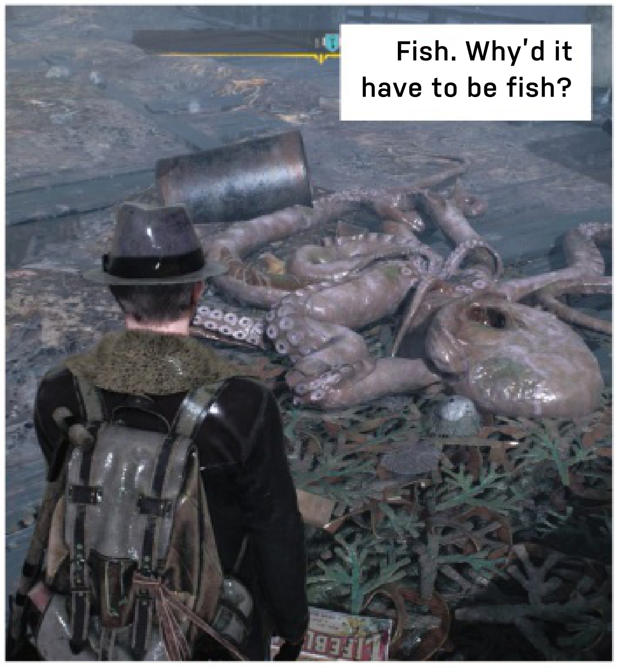
$160, www.steelseries.com

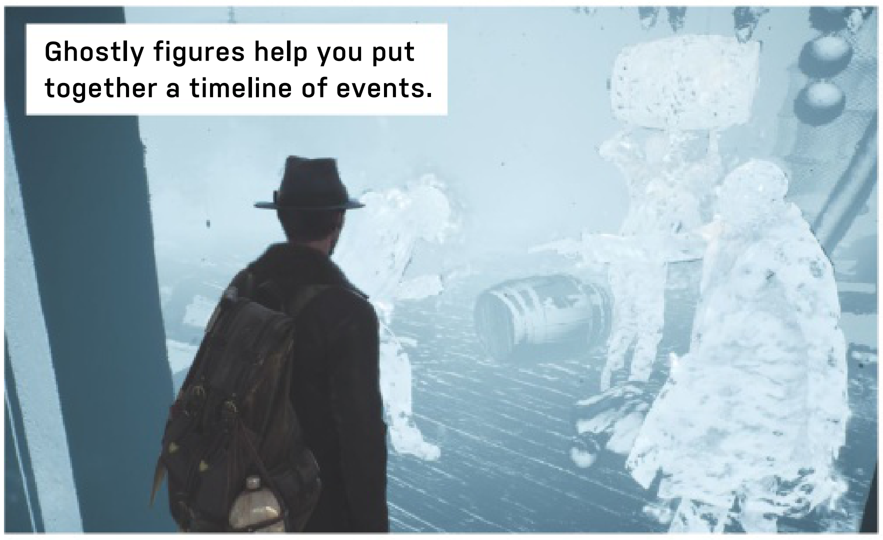
SPECIFICATIONS

Switch Type	SteelSeries Red Linear
Form Factor	Full-size
Media Keys	Yes
Macro Keys	Software-customizable
LEDs	Per-key RGB
N-Key Rollover	104-key
Pass-Through	USB 2.0
Dimensions	15.8 x 5.4 x 0.6 inches
Warranty	Two years

That's easy for you to say.

Cgrah'n hrii grah'n geb hai nglui nafhtagn.


Fish. Why'd it have to be fish?


Ghostly figures help you put together a timeline of events.

Charles Reed has a face that's used to being out in the rain.

Ah, much obliged, Mr. van der Berg. I guess I didn't expect you to mean so literally.

ADVENTURE GAME

The Sinking City

In a house in Oakmont, an investigator lies dreaming

GAMING'S DEBT TO Lovecraft keeps getting bigger. *The Sinking City* takes its source material literally as well as seriously, being based on two of HP's stories: 1920's "Facts Concerning the Late Arthur Jermyn and his Family," and the 1931 novella, *The Shadow Over Innsmouth*.

It starts with an arrival. You, Charles Reed, private investigator, are invited to Oakmont, Massachusetts, where there is fog and rain and discontent and plenty of fish. The beginning is reminiscent of last year's *Call of Cthulhu*, which used similar sources, but took them on a different path.

This slice of mythos certainly begins well, your arrival at the dripping, partially flooded town noted by both the natty dresser who invited you, and the simian Robert Throgmorton, head of one of the city's leading families. One has lost his son, and wants you to find him; the other wants you to investigate strange visions that are plaguing him and others—you end up doing both, and plenty more besides.

Partially flooded, you must use a boat to get to some of Oakmont. Neighboring Innsbruck has suffered a catastrophe, and refugees are flooding in, to be met by hostility from the Oakmont locals. People from all walks of life are suffering supernatural visions, pulling more and more people toward the city.

Having investigated your way out of the docks and into the city itself, the rest of the game is structured as a series of cases and side quests. Scouring every desk, cupboard, and cabinet to find every last scrap of paper and diary means you'll have a good idea of where characters are and what they're thinking.

Clues can be put together in different ways, and you're encouraged to treat each investigation like a jigsaw. Fit it all together, and you'll see a re-enactment in your mind's eye, including events you couldn't possibly know, that will lead you to a satisfying conclusion. Eventually, as the tentacled monsters of the Elder Gods infringe further on our reality, you start to suffer debilitating mental health effects as you plunge closer to insanity. Many investigations end in moral choices that don't have an obviously correct solution, adding more gray to a game drowning under gloom and sea spray.

Then there's the combat. It's not good. Strange beasts and armed NPCs patrol areas of the city, and there's a decent supply of weapons, but there's no thrill to the gunplay, and smaller beasts are better beaten into further undeath.

The Sinking City tries to do so much right in a narrative that takes in religion, politics, race, the Great Depression, and sex with apes (yes), but Oakmont's atmosphere ends up drowning it all in a gush of salty water. **–IAN EVENDEN**

VERDICT 6

The Sinking City

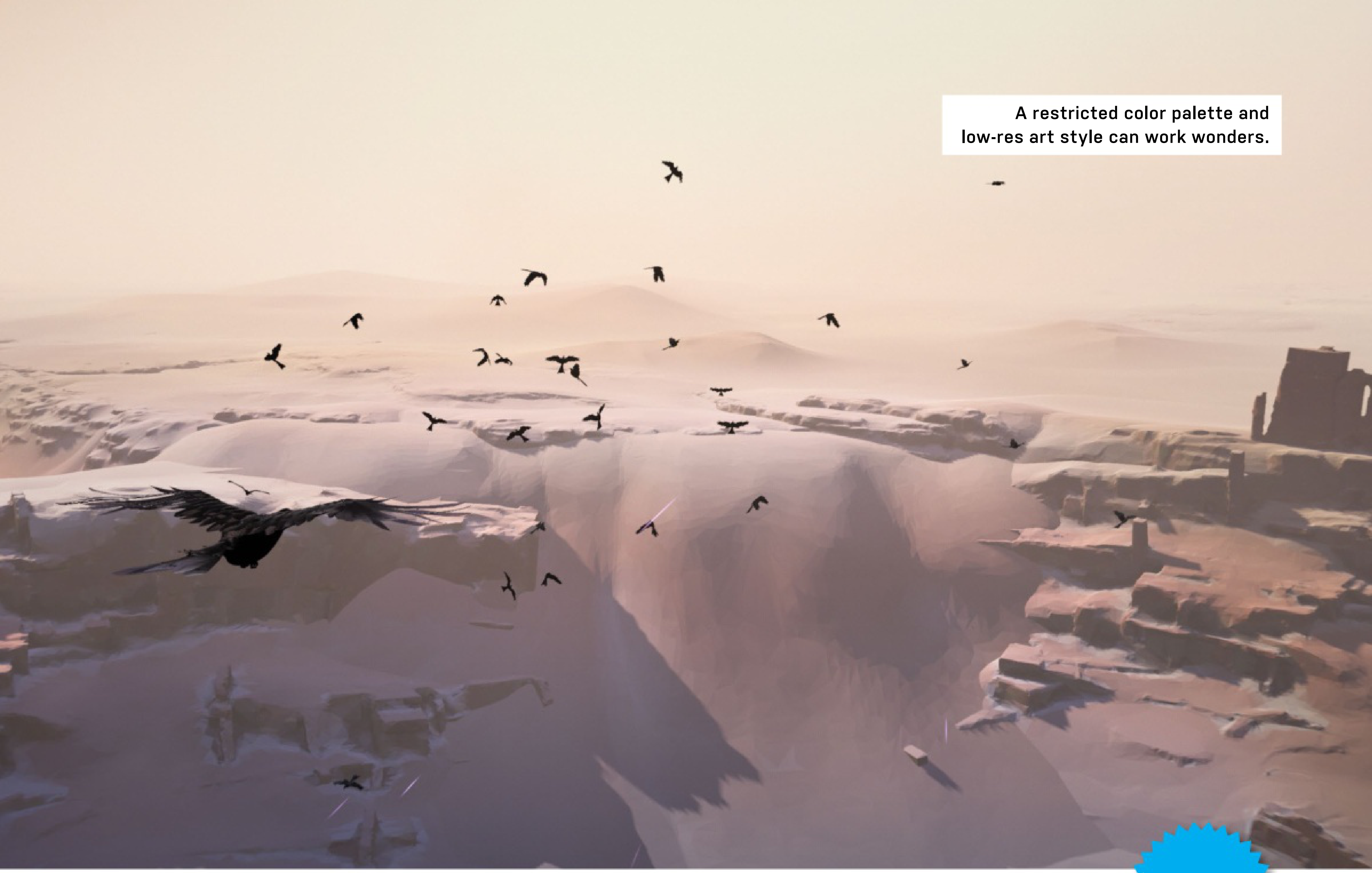
+ FLOOD Interesting stories; oppressive atmosphere.

– BLOOD Poor combat; dull underwater sections; very gray and brown.

RECOMMENDED SPECS i7-3770/FX-8350; 8GB RAM; GTX 970/R9 290.

$60, http://thesinkingcity.com, ESRB: M

© BIGBEN INTERACTIVE


A restricted color palette and low-res art style can work wonders.

© FRIEND & FOE

EXPLORATION GAME

Vane

Soar like a bird, then crash back down to Earth

THERE'S SOMETHING about *Vane* that's so obvious, we need to get it out of the way now, or it's going to clog up our thoughts, and we may never stop talking about it.

Vane is beautiful. It's breathtaking. It's the sort of game that makes us wish we published four-page reviews, just so we could fill three of them with images.

The game runs at 4K, 60fps, highest settings on our GTX 1070 Ti test bed. You may look at the screenshot above and say it runs so well because there's nothing there, just empty desert and low-res cliffs, and we'd have to shuffle slightly and concede the point. There is a lot of empty desert and low-res cliffs, but it's an artistic choice that works, providing a gorgeous backdrop to explore against.

Vane is very much an exploration game. You start as a human, possibly a mother cradling her child, but left ambiguous enough to remain uncertain. She runs through a ruined cityscape being further destroyed by lightning strikes. You're given no direction—that much holds for the entire the game—so you run, finding ways to progress as the wind whips up the fabric of the city into barriers to your progress. Eventually, you meet a tall, bird-like figure. It rejects you, and you fly skyward, swept up by the storm.

Loading. Then you are a bird in the desert. There's no perceivable link to the scene before, so you take off and fly.

The bird appears black, but sparkles and iridesces as the camera and its plumage move, the peaks in its feathers mirroring the triangles the nearby cliffs are clearly built from. The gentlest guidance sets you following a chasm in the rock—there's nothing else to do—so you explore. This is the backbone of the game, and its downfall. Something glints in the distance. You find a structure, gather more birds, move to another structure, bringing the flock together so its weight pushes the spinning apparatus off balance, bringing it crashing down.

Then you're a boy. He can pull levers and free caged birds in ways a single bird never could, but is limited by being stuck on the ground. He still needs to explore, to discover the path that leads to progress. As he does, the game becomes more of a platform game, as you gather more children, and the scenery transforms. It never becomes less than lovely to look at.

Vane lacks focus, and that's unusual in a short game. The tracking through and over the desert is frustrating when you can't find the one thing you need. Later, sluggish movement and sticky scenery have the same effect. *Vane* has cracked half of what it takes to make a great game, let's hope the devs can bring the rest to bear on their next project. Meanwhile, it sure does look pretty. **–IAN EVENDEN**

VERDICT 6

Vane

+ VANE Lush graphics; sweeping soundtrack; marvelous flight.

− VAIN Lack of focus and direction; sticky collision detection.

RECOMMENDED SPECS 2.4GHz quad-core CPU; 8GB RAM; GTX 780/R9 290X.

$20, www.friendandfoegames.com, ESRB: E

LAB NOTES

CHRISTIAN GUYTON, STAFF WRITER

AMD or Not to Be

They might not blow anyone away, but I really love the new Radeon cards

I'VE HAD THE GOOD FORTUNE to play about with both of the new Radeon cards, and I'm impressed. No, not Titan RTX impressed, more of a sort of quiet, begrudging nod of acknowledgement to Team Red on a job well done. The RX 5700 might genuinely be one of the best value 1080p cards available right now, and it's more than capable of punching above its weight at 1440p in many games. I have a real soft spot for its clean, stripped-back design, too. It's all right angles and smooth, brushed metal—nothing flashy, but it still looks right at home inside just about any build.

Its big brother, the RX 5700 XT, doesn't quite nail the aesthetics. With its odd dent (is it for airflow? A thumb grip for waving it around? Who knows?) and horizontal lines covering its metal shroud, it doesn't look as good. It's powerful, though, comfortably outpacing Nvidia's similarly priced RTX 2060 Super at 1440p. I'm considering getting one for my home PC—a rig I primarily use for online gaming—but I might have to wait until there are some nicer-looking variants. Come on, Sapphire, I'm waiting on you.

Nvidia is still king when it comes to high-end GPUs, though. Even the Radeon VII, AMD's workstation graphics solution, doesn't even touch the performance of the RTX 2080 and better cards. With Intel promising (threatening?) a venture into the GPU market within the next two years, AMD needs to show its teeth and put out a proper gaming competitor to the likes of the already one-year-old RTX 2080 Ti. For now, though, I'm pleased to see that Team Red is still alive and kicking when it comes to graphics cards.

The closest you'll get to an RX 5700 XT teardown from us. We're not wrecking ours.

© AMD

ALAN DEXTER

Executive Editor

I've been driving a lot these last few months, and gotten tired of my cell running out of charge when moonlighting as a GPS. I know in-car chargers exist, I just didn't have one when needed. Which is why I turned to the Garmin GPS that has been languishing in my glovebox for… well, for quite a while. It worked fine, mostly, even if the interface felt a tad clunky, right up to the point where I found myself driving on a road that the Garmin didn't know existed. Much confusion ensued as it saw me gliding across seemingly open country. Afterward, I discovered that I hadn't updated it since 2011. Ah, yes, manual updates. I had completely forgotten about those.

BO MOORE

Hardware Lead

You may remember a few months ago I mentioned diving back into *Final Fantasy XIV* after a long time away from MMOs. Now, a few months and over 100 hours of playtime later, it's safe to say I'm enjoying myself. *FFXIV* is in a great spot right now, thanks to its third expansion, *Shadowbringers*. I'll admit it was a bit of a slog having to play through a few years' worth of content in order to catch up to *Shadowbringers*, but the pay-off has been so worth it. Its story functions as both a continuation of the ongoing saga and a great standalone adventure—taken alone, it's among the best stories the whole *Final Fantasy* series has offered. Needless to say, I'm hooked.

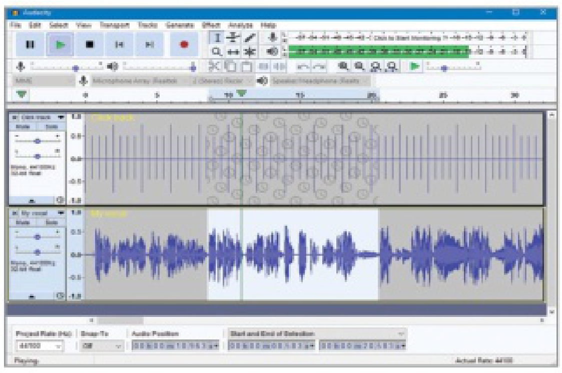
Editors' Picks: Digital Discoveries

Senior editor, Jarred Walton, and hardware staff writer, Joanna Nelius, have been playing around with audio

AUDACITY

The best things in life are free, or so I've heard. When it comes to computers and software, however, that's often not quite true, but the free and open-source Audacity is my go-to utility for recording and editing audio. Even better, for those of you who don't particularly care for Windows, it's available and works great on OS X and GNU/Linux as well. To be clear, I'm by no means a recording professional. I'm sure there are other tools that are better in various ways. I'm also sure they cost way more money. But Audacity gets the job done for when I'm recording voice-overs and editing audio tracks, and I'm really only scratching the surface of what it can do. The application supports a variety of plugins and effects, quick and simple editing commands, and imports/exports every audio format I've cared to use. Want to play with MIDI files? It can do that as well. We're basically in the golden age of computing, as far as I'm concerned, where tools and software that used to cost hundreds of dollars are now available for free—though you can make a donation if you want, which I'm sure the Audacity team would appreciate.

Free, www.audacityteam.org



LOGITECH G560 LIGHTSYNC SPEAKERS

I've been in love with these speakers since I got them as a birthday gift, and I'm glad I don't have downstairs neighbors. My previous set of PC speakers was some 20-year-old Bose system, where the mute/unmute touchpad had a mind of its own. (It was like a ghost kept touching it.) So, I was using a headset for so long I forgot what a satisfying bass pulse felt like when it bounced off the walls and rippled through my ear drums into my chest. The G560 comes with a subwoofer as big as my torso, two speakers with RGB lighting that you can sync with your game or music, and it's all compatible with 7.1 DTS:X. If I don't need to be in game chat, I'll use these speakers for sound instead, because the directional sound quality is just as good as most gaming headsets—not as immersive, but with the surround sound enabled, it's pretty darn close. I could tell if footsteps were quickly approaching behind me or if there was gunfire in the distance while playing *Overwatch* and other multiplayer FPSes. And, if you open the Logitech G Hub to fine-tune the sound, you'll see that every volume control goes up to 11. How's that for a nod to the film *This is Spinal Tap?*

$200, www.logitechg.com

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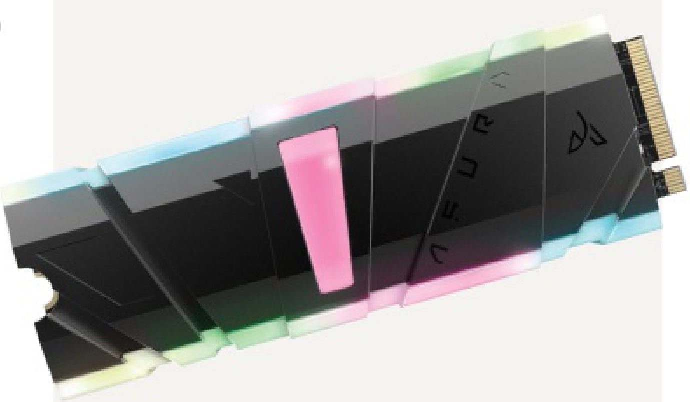
GEEK TESTED & APPROVED



Asura Genesis Xtreme 1TB

AN M.2 SSD might not be the usual fare for the "Geek Tested" column, but this one's a bit different. With Gen4 NVMe arriving, Gen3 M.2 drives now taking something of a back seat in this fine publication, but we really wanted to squeeze the Genesis Xtreme in. You probably haven't heard of Asura before, because it was founded barely a year ago in Chino, California, and the Genesis Xtreme is its very first commercially available product. Focused on bringing high-end hardware to enthusiasts around the world, Asura currently only has the one product, although its upcoming "Steel Series" and "Titanium Series" lines promise more top-quality components. Asura states that its premium parts focus on "quality, performance, and reliability," and that certainly seems to be the case with the Genesis Xtreme. As Gen3 M.2 SSDs go, it manages to impress. It reliably reached 3GB/s of both read and write times in our benchmarks, which pretty much puts it on a par with other high-speed SSDs at the same price. It's generally a solid piece of hardware, providing a good amount of M.2 storage for under 200 dollars. The USP here is the RGB lighting on the drive—it's fairly subtle, pulsing in a light rainbow pattern that easily matches with various other lighting effects. The drive is fairly bulky, so it might demand careful situation on some motherboards, but the side panels and part of the heatsink can be easily removed if a smaller profile is needed. **–CG**

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON…

> Gaming History
> Firefox Passwords
> PC Maintenance

Historical Gaming

I really enjoyed your article on early computer games. The one that got me hooked on gaming was called *Snoopy & The Red Baron.* It ran on a Datapoint 2200 in 1971, a "microcomputer" about the size and weight of two toaster ovens that utilized cassette tapes. It was simply an X and O chasing each other around a cathode ray tube. My five-year-old son used to come in to work with me on weekends just to play it. I was amazed that he learned the game in about 10 minutes and became instantly comfortable with the computer. I was responsible for training users and this gave me the idea of loading games on every new device we purchased. Users previously afraid of computers became instant computerphiles!

–Dave Szatkowski

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: It's often easy to discount gaming on computers, but for many it is an important gateway to using them and getting used to them. I still have (oddly) fond memories of tweaking the config.sys file to load the kernel into high memory area so that games would actually run. In other news, John Knight will be revisiting the formative years of the PC in a forthcoming feature. Watch this space.

Password Fox

I read your excellent article on Dashlane. While that is a great password manager, what do you think about using Mozilla Firefox with a strong master password? Provided one likes using Firefox, this appears to meet all the criteria. The data is encrypted. Two-factor authentication is an available option. There is the choice to save a recovery key (hopefully someplace ultra-safe). It stores logins and passwords locally (and, with a Sync account, in the cloud). It can sync on just about any modern device. By checking various box options while in Windows, Mac, or Linux, one can also sync bookmarks, addresses, and a whole lot more. I realize there are drawbacks and concerns with various password managers—where would you place Firefox in the pack on a scale of one to 10? **–Salvatore Fattoross**

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: The most important thing about password managers is that you use them, and if you're a fan of Firefox already, the job is mostly done. One thing we would recommend is setting up that master password (pick a complex password), so that it encrypts your data using a 256-bit AES cipher. There are some concerns over Firefox Sync, as the way this encrypts your data changed back in 2014 to a more useful, if slightly less secure, model, which raised alarm bells for some. As for a score, we don't tend to give such tools scores, so giving one to Firefox when other options don't have one seems odd, but we do think it's a system worth using.

Keep It Clean

I have been a subscriber for over 10 years and I really like and enjoy your magazine. I am currently using Auslogics Boostspeed. However, due to the new version's excessive cost, I am considering purchasing PC Matic instead. For PC maintenance, what product(s) do you recommend or use to accomplish things such as: disk defragging, disk optimization, registry cleaning, registry defragging, Internet optimization, Windows tweaks, and so on?

–Wesley M. Martin

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: This is purely down to personal preference, but I tend to avoid suites that promise to do everything for you, because there have been enough of these offerings over the years that just seem bloated compared to tools that do specific tasks. For instance, we tend to run SSDs on our machines these days, so disk defragging isn't an issue anymore (you shouldn't defrag SSDs), and disk optimization is a bit moot as well. To this end, I'd recommend using the likes of CCleaner to sort out your

↘ submit your questions to: comments@maximumpc.com registry, whatever tool is relevant for your SSD (such Samsung Magician), and then fill in any gaps using the tools we recommend in our regular Windows optimization features.

Tiniest PC

Maybe you've already done it, but if you haven't, why not set up a challenge to build the smallest possible computer, à la Raspberry Pi? Can we do better than the Pi? And what would be the requirements? One would have to be that you can get out on the Internet—what else?

–Geoffrey Nicoletti

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: This is the kind of challenge we can get behind, Geoffrey, and it will be interesting to see what the extra money nets you, particularly as the Raspberry Pi 4 now sets the bar much higher. Being able to run Windows 10 is an obvious place to start (and all the goodies that come with that), as well as more memory, a dedicated graphics processor, and speedy main storage (possibly the Raspberry Pi's weakest aspect)—that all makes for a much more capable machine, although at a much higher cost. Consider us intrigued.

[NOW ONLINE]

HOW ARE MICROCHIPS MADE, ANYWAY?

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Modern computers are built out of a collection of seven primary components: the CPU, GPU, RAM, storage, motherboard, case, and power supply. Each of these—yes, even the case—now contains anywhere from a few microchips to potentially hundreds of chips that handle a wide variety of tasks. Audio, communication, graphics, storage, and, of course, the CPU, aka central processing unit. The primary building block of our modern computers is the silicon microchip, but what exactly is a microchip, and how is it made? It's a fascinating and incredibly complex topic, so we're going to give you the ultra-condensed version.

Microchips, microprocessors, CPU, GPUs, or whatever you want to call them are fundamentally similar. They're all made from semiconductors, typically on 300mm silicon wafers, which in turn are cut from a large silicon crystal cylinder. Those silicon cylinders are where everything starts, and they're grown from a seed crystal dipped into a molten vat of nearly pure silicon. That "nearly" bit is important, however, because small impurities in the wafers can lead to errors or non-functional parts.

Read the full article: https://bit.ly/3006uCS

More Than Gaming

I have an even better and cheaper solution for your movie- and game-playing readers. It's called the Steam Link. It isn't just for playing games. You can use it to do almost anything you can do on your PC, while sitting in front of the TV on your couch or chair. To activate it, connect a mouse and/or keyboard and turn that device on. When launched, it tries to connect to any PC on the network running Steam. It will connect up right away and give you instant access to everything in the Steam library. But here is the tricky part: At the top-right is the power button; click, and in the list find "Exit Big Picture Mode." Once you do this, Steam reduces to a window on your PC. You now have full access to run any program you wish. No need to have a full-blown PC in your living room. You now have the full power of your PC from your couch or chair. I used Plex for years and it could be very frustrating, because some content never appeared correctly, no matter what I tried. But now instead of putting a PC by the TV, with all that entails, I have the best of both worlds.

–William Horn

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: Nice tip, we hadn't actually thought of doing this. It's a shame that the device has been discontinued, although if anyone's interested in doing this, you can pick them up on eBay pretty cheap (to be fair, they were cheap anyway). We had a Steam Link languishing in a drawer in the office for so long we actually gave it away to a colleague in the end, which we may now be regretting after reading your letter….

Next-Gen Audio

I really enjoyed reading "The Sound of Silence" by Phil Iwaniuk, as well as his review of the EVGA Nu Audio soundcard. I do wonder, though, given its specs, why does it have an SPDIF-out but not HDMI? However, given that the next PlayStation (consoles are basically mid-range gaming PCs) has a custom 3D audio chip for more immersive, positional sound, are we likely to see a new generation of soundcards engineered for enhanced immersive game audio, similar to how we rely on graphics cards for improved visuals?

–Julián Parrilla Grajales

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: While it would be great to think that soundcards are about to get a new lease of life, the fact of the matter is that they're now seen as a commodity—something that is used as an upsell for the more expensive motherboards. Add-in cards are a bit of a niche consideration, and the really good options are still the reserve of audiophiles and audio professionals. Still, we'll enjoy a moment of optimism and hope that next-gen consoles do give audio hardware a boost.

Gaming Genres

Just a suggestion: When writing your game reviews, could you specify the genre of that game, such as FPS, RPG, MMORPG, and so on? This way, it is easier for the readers to focus on what is appealing to them.

–Oleg Kravt

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: Good idea. So good, in fact, that we've started doing this already. I hope you like the change.

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THE BUILDS

BUDGET

INGREDIENTS

PART		PRICE
Case	BitFenix Nova TG	$60
PSU	Corsair VS450 80+ White 450W	$50
Mobo	ASRock B450M R4.0 AM4	$60
CPU	AMD Ryzen 5 2600X	$160
GPU	Zotac Gaming GeForce GTX 1660 6GB **NEW**	$220
RAM	8GB (2x 4GB) Team T-Force Vulcan Z @ 3,000MT/s **NEW**	$42
SSD	120GB Crucial BX500 2.5-inch	$21
HDD	1TB Seagate Desktop ST1000DM003 **NEW**	$32
OS	Ubuntu Desktop Linux 18.04 LTS 64-bit	$15

Approximate Price: $660

WE PLAYED WITH THE IDEA of putting some new toys into the budget build this month, what with the advent of the Ryzen 3000 series of CPUs, but ultimately we opted to keep the cost down. New X570 motherboards, which are really needed to get the most out of those processors, are expensive, while the trusty ASRock B450M R4.0 just keeps getting cheaper. We also swapped out the GTX 1660 GPU from EVGA to Zotac to preserve the price, and last month's Geil RAM was no longer on sale, so back to Team Group's T-Force line we went, sticking with a two-piece kit that would offer comparable performance. Perhaps the biggest change here was finally switching out Seagate's trusty Constellation hard drive for its Desktop ST1000DM003 model of the same size, which is slightly cheaper but has a larger cache of 64MB, as opposed to the Constellation's 32MB.

MID-RANGE

INGREDIENTS

PART		PRICE
Case	Fractal Design Meshify C	$90
PSU	500W Cooler Master MWE 500 Silencio 80+ Bronze **NEW**	$55
Mobo	ASRock X570 Phantom Gaming 4 **NEW**	$145
CPU	AMD Ryzen 5 3600X **NEW**	$250
Cooler	AMD Wraith Spire **NEW**	$N/A
GPU	Sapphire Radeon RX 5700 8GB	$350
RAM	16GB (2 x 8GB) Ballistix Sport LT @ 3,200MT/s **NEW**	$70
SSD	250GB Samsung 970 Evo Plus M.2 PCIe	$70
HDD	1TB Seagate Desktop ST1000DM003 **NEW**	$32
OS	Windows 10 Home 64-bit OEM	$100

Approximate Price: $1,162

BIG CHANGES AHEAD this month for our mid-range build. The first step was to upgrade the processor, going straight for the high-quality Ryzen 5 3600X, with a hefty base clock of 3.8GHz. These new 3000-series CPUs aren't too power-hungry either, meaning we could safely dial back the PSU to Cooler Master's 500W Silencio. Although this won't leave too much additional power for overclocking, the Ryzen 3000 processors don't have much overclocking headroom anyway. To support the new CPU, we needed a new motherboard: the X570 Phantom Gaming 4 from ASRock, one of the best value X570 boards available right now. We're opting for the stock Wraith Spire cooler here to keep the price down, but if you've got the money to spare, an AIO cooler isn't a bad idea. Lastly, we've changed up the memory and HDD to help offset the extra cost of the CPU and motherboard.

TURBO

A WIDE SELECTION OF CHANGES led to a significant saving on the Turbo build this month, lowering the price by over $100. Most crucially was a new GPU: the RTX 2070 Super. Thanks to its upgraded architecture, this new card provides performance only marginally beneath the original 2080 for a significantly lower price. We've gone with a twin-fan offering from EVGA, costing a measly $520 for a 1440p powerhouse. The RTX 2070 Super is so good that we even considered putting its little sibling the 2060 Super in our mid-range build, but if we were planning on raising the price by that much, we'd have chosen the Radeon RX 5700 XT instead.

There wasn't much need to change the processor; while we considered the new Ryzen 9 3900X, the fact is that Threadrippers are simply more powerful. As such, the motherboard didn't need re-evaluating either, although we did spring for a cheaper AIO cooler from Fractal Design for the 2950X (albeit a less flashy one).

Lastly, the dawn of Gen4 M.2 drives has led to a pleasing drop in prices for previous-generation NVMe SSDs. This may not last, so if you're looking to upgrade your storage, now might be the best time to do so. The Samsung 970 Evo we had been using dropped in price so much that we decided to upgrade to the 970 Evo Plus, netting us superior SSD performance without having to raise our storage budget. At $120 right now, the 970 Evo Plus is an absolute steal.

For more of our component recommendations,
visit www.pcgamer.com/hardware/buying-guides/

UPGRADE OF THE MONTH

© EVGA

EVGA GEFORCE RTX 2070 SUPER BLACK GAMING 8GB

The new Super cards are, to put it bluntly, just good products. They're not particularly exciting, but what they set out to do, they achieve with gusto. The improvements over their original counterparts are modest, but significant enough to make a difference, and this was achieved without raising the price tag, too. The 2070 Super is far closer in both performance and internal design to the original 2080 than the 2070, and that really makes a difference in game. **$520, www.evga.com**

INGREDIENTS

PART		PRICE
Case	NZXT H700i	$190
PSU	850W Corsair TX-M Series 80+ Gold	$120
Mobo	ASRock X399 Phantom Gaming 6	$240
CPU	AMD Threadripper 2950X	$830
Cooler	Fractal Design Celsius S36 Blackout 360mm AIO **NEW**	$120
GPU	EVGA GeForce RTX 2070 Super Black Gaming 8GB **NEW**	$520
RAM	32GB (2x 16GB) Ballistix Sport LT Red @ 3,200MT/s	$156
SSD	500GB Samsung 970 Evo Plus M.2 NVMe **NEW**	$120
HDD	2x 3TB Seagate BarraCuda Compute	$160
OS	Windows 10 Home 64-bit OEM	$100
Approximate Price:		**$2,556**

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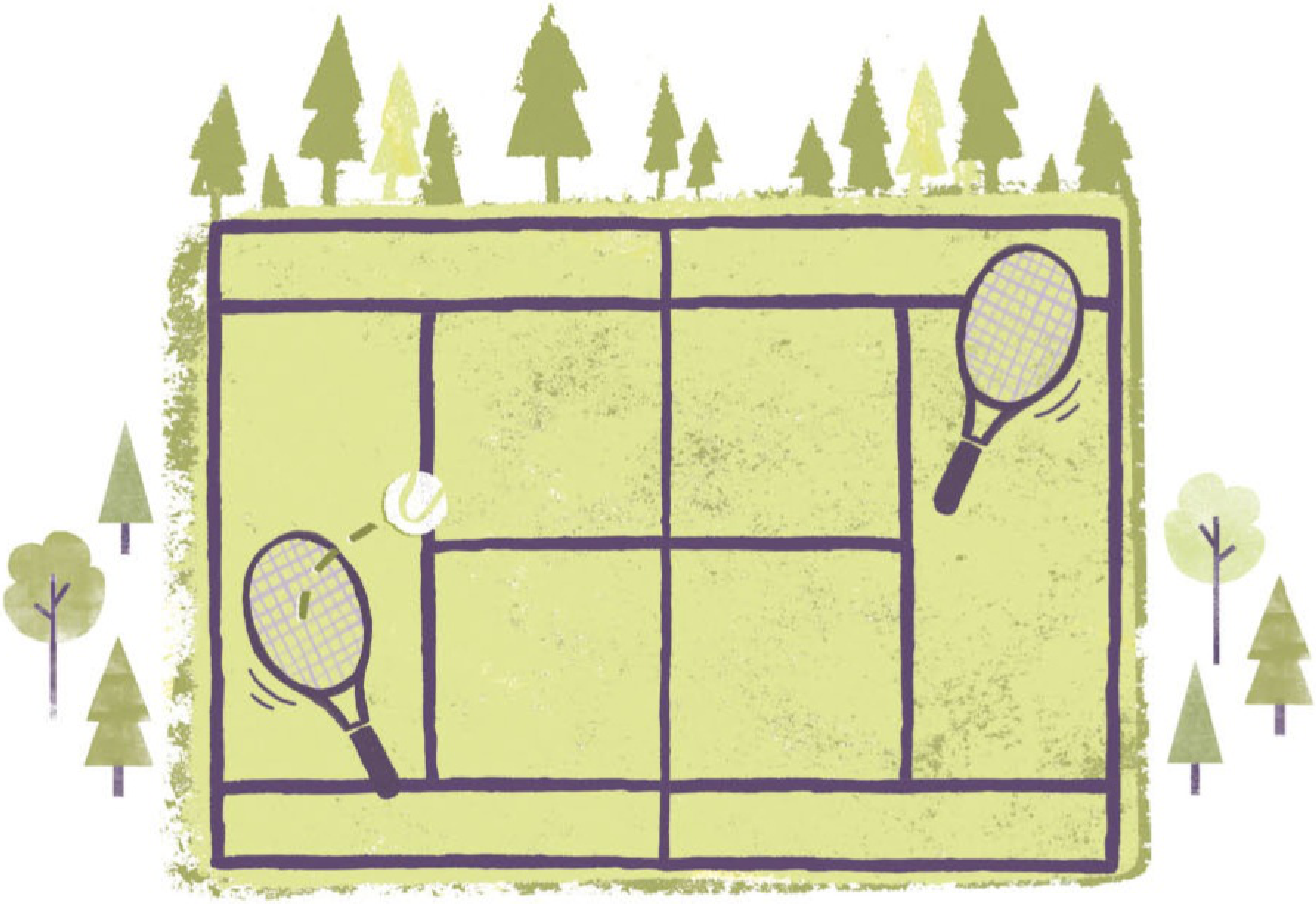

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